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(English Edition)

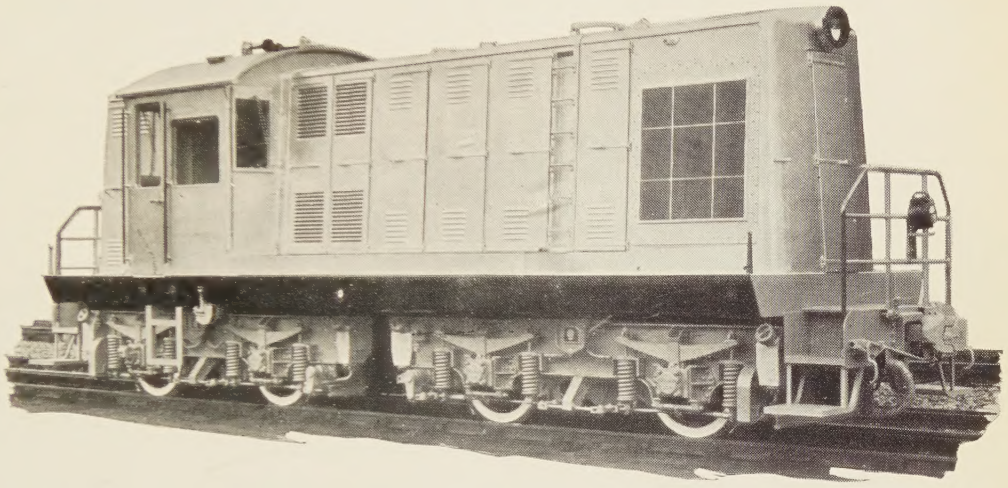




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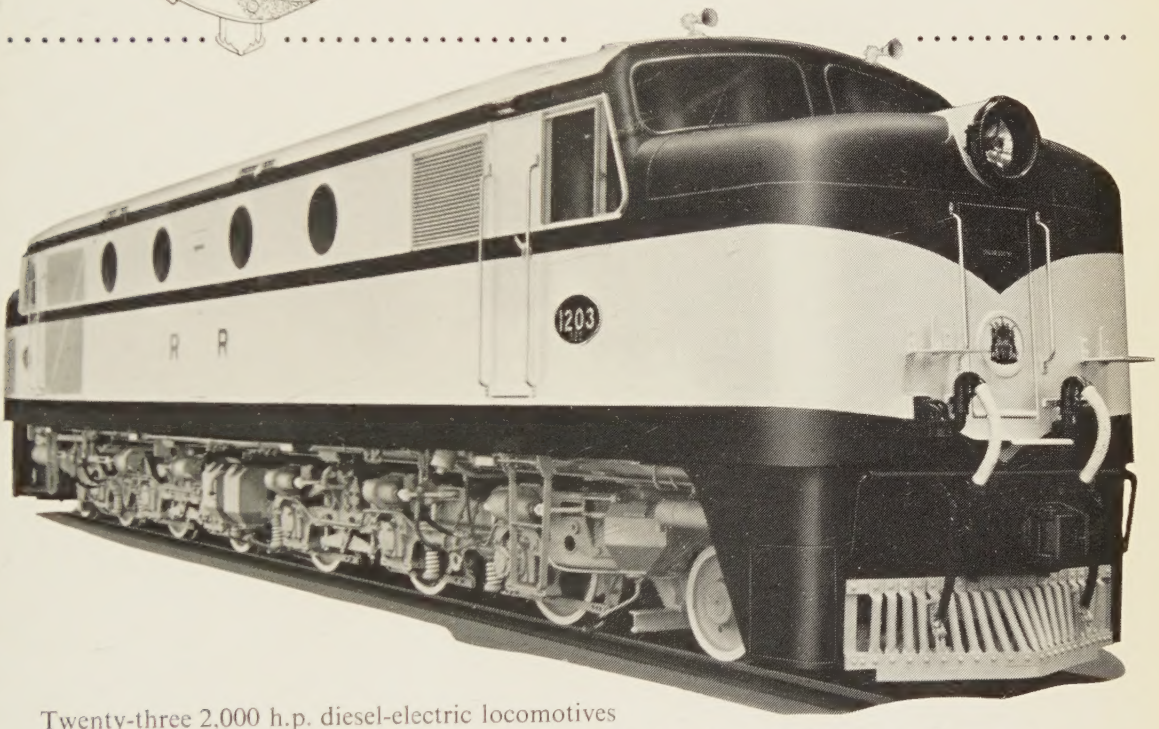
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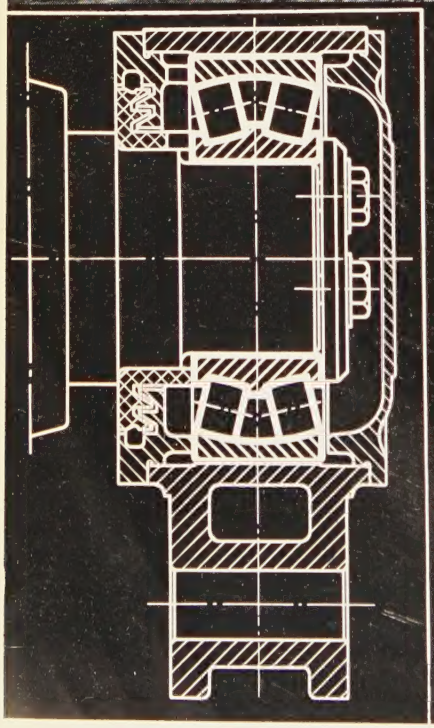
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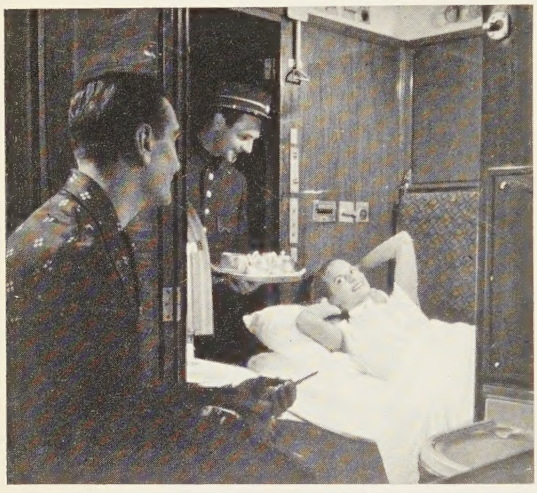
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TIME-TABLE

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8.43 a. m.	Brussels M.	9.15 p. m.

B

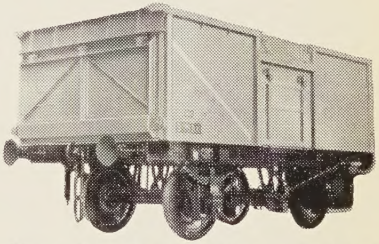




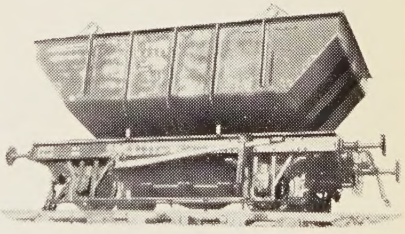
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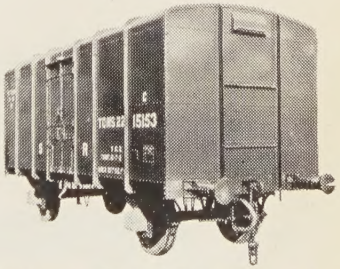
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V. J. M. Hopper-type Wagon with drop bottom door for coal, as used by Queensland Government Railways, Australia.



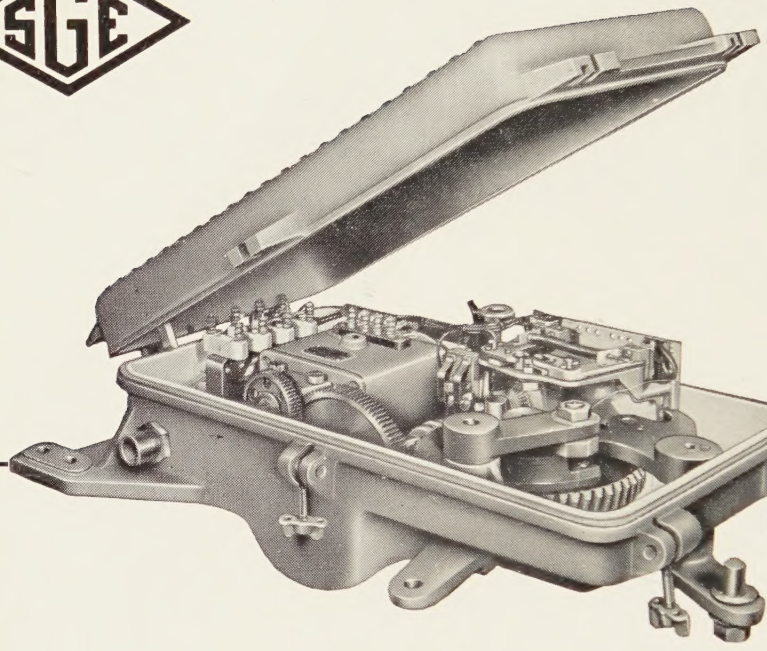
Broad gauge Covered Wagon type C.R. as used by Indian Railways.

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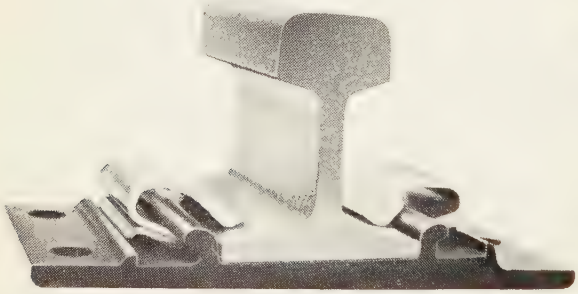
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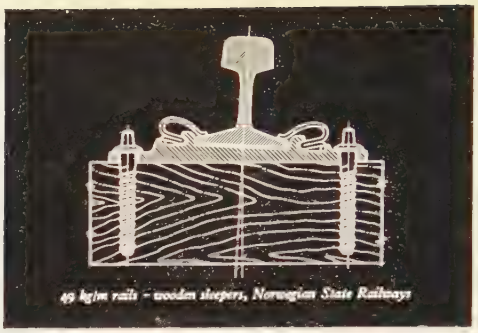
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- Equally serviceable on timber and concrete sleepers.
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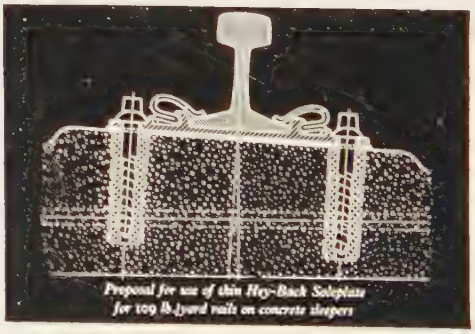
49 kg/m rails – wooden sleepers, Norwegian State Railways



109 lb./yard rails – wooden sleepers British Railways



49 kg/m rails – concrete sleepers, Norwegian State Railways



Proposal for use of thin Hey-Back Soleplate for 109 lb./yard rails on concrete sleepers

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MONTHLY BULLETIN

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

(ENGLISH EDITION)

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Advertisements : All communications should be addressed to the Association, **19, rue du Beau-Site, Brussels.**

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OF THE

Permanent Commission of the International Railway Congress Association

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An edition in French is also published.

Vol. XXXV. — No. 8. August 1958.

BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[625 .143]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

17th. SESSION (MADRID, 1958).

QUESTION 2.

Very long rails. Welding methods. Transport of long welded rails and necessary equipment for transporting, laying, fixing, ballast, tamping, etc.
Economic aspect of the question. Present tendencies.

REPORT

(Austria, Belgium and Colony, Bulgaria, Cambodia, Czechoslovakia, Denmark, Ethiopia, Finland, France and French Union, Western Germany, Greece, Hungary, Indonesia, Italy, Lebanon, Luxemburg, Netherlands, Poland, Portugal and overseas territories, Rumania, Siam, Spain, Switzerland, Syria, Turkey, Union of Soviet Socialist Republics, Viet-Nam and Yugoslavia),

by A. Crespo Mocorrea,
Chef du Département des Etudes et Reconstructions, Réseau National des Chemins de fer Espagnols, Madrid.

FOREWORD.

For more than a century, the rail joints have been the weak point of the track and have an important repercussion on railway costs as a whole, both on account of the high cost involved in maintaining their level, and on account of the premature wear they cause to the installations and rolling stock.

The joints are also at the bottom of any lack of smoothness in the running and the cause of the tiresome noise that occurs as the wheels of the vehicles pass over them.

It is therefore only natural that endeavours have been made to overcome these pernicious effects, either by means of the costly machining of the ends of the rails, or by modifications in the arrangement of the sleepers, or by the introduction of new types of fishplates. All the solutions which have been proposed during the course of a century with greater or lesser ingenuity having failed, it became necessary to be resigned to the existence of joints as a necessary evil and endeavour to reduce their harmful effects by decreasing their number by increasing the length of the rails.

At the beginning of the present century, the standard length for rails was generally 12 m, whilst a few years later the railways adopted 15 and 18 m long rails, which at that time were known as « long rails ». Subsequently the ironworks were asked to

supply longer rails, 24, 30, 36, 48 and up to 60 m, and even if there was no improvement in the quality of the joints in this way, there was at least a considerable reduction in their number.

Trials of these long rails on the permanent way showed that the width of the gap which it was necessary to leave between them was not necessarily proportionate to their length, and this observation did away with the false belief in the free expansion of rails, a belief firmly fixed in the minds of permanent way engineers.

Once the error of free expansion for rails of more than 24 m was perceived, the way was open to making up on the permanent way rails of lengths that had never been dreamed of before.

In 1924, the *Deutsche Reichsbahn* carried out trials near Nuremberg with rails 320 m long, and in 1935 laid some trial sections each having rails 1 000 m long. In the middle of 1949, the French National Railways laid on a line with very heavy freight traffic (Longueau-Estrées-Saint-Denis) in the Nord Region, 7 km of 293 m long rails, made up from second hand 46 kg/m rails.

Since that year, both the D.B. and S.N.C.F. have used long welded rails without joints to an ever increasing extent, and their success has been so striking that for some years these two Administrations have considered such rails to be the standard type on their permanent way, whenever they are not obliged for other reasons to use 30, 36 or 48 m long rails. At the present time, each of these two Administrations have several thousand kilometres of long welded rails without joints.

Although in 1943, in the U.S.A. the Elgin Joliet & Eastern Railroad, 236 miles long, whose traffic is almost entirely freight, made long welded rails without joints of various lengths — one of them 6 038 m — some of the Companies in that country were slower in introducing the technique of long rails without joints than the European railways.

Encouraged by the success of long rails without joints on the D.B. and S.N.C.F., other railway Administrations have made trials of a similar technique on a much smaller scale, thanks to which, apart from their own personal experience, it is possible to know how long rails without joints will stand up in different countries under very different conditions.

As the making of long rails without joints is without any doubt the most important event which has occurred in permanent way technique, and as in addition, during the years since it was first attempted considerable experience has been acquired regarding their behaviour, the Permanent Commission very wisely decided to include amongst the subjects to be dealt with by the First Section — Way and Works — of the Madrid Congress, the question of very long welded rails.

The questionnaire consisted of five chapters :

I. Definition of long rails and statistical data.
II. Usefulness of using long welded rails.
III. Manufacture of long welded rails.
IV. Laying long welded rails.
V. Maintenance of permanent way laid with long welded rails.

Each of these chapters is subdivided into several questions, the text of which is given at the head of the summary of the replies received.

The questionnaire was sent to 78 railway Administrations and 41 replies were received, 20 of which stated they were unable to answer the questionnaire since they did not use long welded rails.

1. Definition of long rails and statistical data.

1.1. — *After what length does your Admininstration make use of the expression « long welded rail » (L.W.R.), seeing that by this we mean a rail the central part of which never undergoes any movement as a result of temperature variations ?*

Some Railways raised objections against accepting the expression « long welded

rails » — L.W.R. — to designate lines made of long rails under the conditions reported in paragraph 1.1.

These Administrations stated that the term L.W.R. should only be used for rails longer than the standard rail used by any Railway system which, though made up by welding, is relatively short, for example 24, 30 or 50 m. According to these Railways, track consisting of two very long welded rails should be called « jointless track » or « gapless track ».

In spite of this, as track without gaps was called L.W.R. in the questionnaire, in order not to cause confusion, the abbreviation L.W.R. will be used in the present report to designate track meeting the condiitons laid down in paragraph 1.1.

The length of welded rail, to which the term L.W.R. should apply, varies considerably from one Administration to another. In the case of the *Swiss Federal Railways* — C.F.F. — the expression L.W.R. must be applied to rails longer than 36 m; on the Rhaetian Railway, to rails longer than 48 m; while the D.B., the Austrian Railways (Ö.B.B.) and the Belgian National Light Railways (S.N.C.V.) fix the limit at 60 m, the French National Railways (S.N.C.F.) — and the Polish State Railways at 100 m and the rest of the Administrations consulted only apply the term to rails more than 200 m long.

The D.B. call 60 m long rails L.W.R. as it appears from the theoretical studies of various authors that rails of this length have almost the same thermic compression stresses as L.W.R.

1.2. — *Please show in table form the general information collected about L.W.R. used on main lines :*

a) *overall lengths of the principal sections laid with L.W.R.;*

b) *total cumulative length of the sections so laid compared with the total length of main lines on your system;*

c) *maximum speed allowed over the L.W.R.;*

d) *gross daily tonnage on the most important sections;*

e) *maximum temperature variations :*

1° annual,
2° daily,

in regions where the L.W.R. are assembled (the temperatures are taken as measured in the railhead);

f) *kind of sleepers — wood, steel or concrete; number per kilometre;*

g) *method of fastening the rails to the sleepers;*

h) *kind of ballast;*

i) *methods of welding used;*

j) *are expansion devices used or not ?*

k) *year when L.W.R. were first introduced;*

l) *quantity of ballast per kilometre of track ?*

m) *type of joint at ends of L.W.R. ?*

n) *are rubber pads used between rail seat and sleeper, sleeper chair and sleeper or rail seat and sleeper chair ?*

The attached table sums up the replies from 21 railway Administrations who replied in detail to the points in question 1.2.

This table shows that the D.B. and S.N.C.F. are the two Administrations which considerably exceed all the others because of the extensive use they have made of L.W.R. — the former having 5 645 km and the second 3 145 km on the 1st January 1957.

The length of the L.W.R. used by the Dakar-Niger Railway which belongs to the French Overseas Railways, and by the Cameroons Railways — both metre gauge railways — is very great compared to the extent of their systems. The former has welded rails from one station to the next, for lengths of from 8 to 36.7 km, and the second for lengths of 4 to 5 km.

STATISTICAL DATA		HOLLAND	ITALY	LUXEMBURG
		Netherlands Railways (N.S.)	Italian State Railways (F.S.)	Luxemburg Railways (S.N.C.L.)
		12	13	14
(a) Length of track laid on sleepers	km	9.4	258	1.4
	wood		(in the stations)	0.4
	concrete	9.4		1.0
	steel			
(b) Ratio between lines with L.W.R. and rest of system	%	0.2	1	0.4
(c) Maximum speed over L.W.R	km/h	125	160	110
(d) Maximum gross daily tonnage over L.W.R	tons	21 300	40 000	14 000
(e) Maximum temperature range	annual	90°	70°	52°
	daily	27°	40°	18°
(f) Number of sleepers per km	wood		1 500 to 1 666	1 667
	concrete	1 533		1 425
	steel			
(g) Type of fastening. Sleepers	wood		GEO	
	concrete	RN clips		coachscrews clips, bolts
	steel			
(h) Kind of ballast under sleepers	wood		30 60	40 60
	concrete-steel			40 60
(i) Method of welding		Thermit	Thermit	Arc
(j) Expansion devices		yes	no	yes
(k) Year when laying began		1954	1951	1954
(l) Quantity of ballast m^3/km Sleepers	wood	1 000	2 000	1 300
	concrete			
	steel			
(m) Type of joint at ends of L.W.R.		expansion joint N.V.N.S.	normal	expansion joint S.N.C.L.
(n) Use of bearing plates on sleepers	wood	rubber	poplar wood	rubber
	concrete			
	steel			

POLAND	*PORTUGAL*	*U.S.S.R.*	*SWITZERLAND*		*TCHECO-SLOVAKIA*	*TUNISIA*
olish State Railways	*Portuguese Railways*	*State Railways*	*Swiss Federal Railways (C.F.F.)*	*Rhaetian Railway*	*State Railways*	*Tunisian Railways*
15	16	17	18	19	20	21
10	6	20 20	38	4		1.1 1.1
			1	1	1	
100	100	100	125	65	110	105
	7 000		45 000	1 000	70 000	2 500
82° 31°		105° 48°	70° 30°	50° 30°	90° 40°	44° 25°
1 560 1 560	1 667	1 840 to 2 000	1 667 1 667 1 667		1 620 1 620 1 620	1 667
clips	RN claws	special GEO	various various various	elastic spikes	clips	RN clips
25/63			25/63 25/63		40/70 25/40	20/50
Flash Arc	Arc	Arc	Flash Thermit Secheron	Arc	Flash Arc	Thermit
no	no	yes	yes	no	no	yes
1955		1951	1951	1951	1954	1953
1 600	1 590		1 520 to 1 725	1 000	1 580 1 580 1 580	1 200
normal		expansion joint U.R.S.S.	expansion joint	normal	normal	expansion joint S.N.C.F.
oplar wood			rubber rubber rubber		rubber rubber	rubber

STATISTICAL DATA		WESTERN GERMANY	AUSTRIA	BELGIUM		
		Deutsche Bundesbahn D.B.	Öster-reichische Bundesbahnen Ö.B.	Belgian National Railways S.N.C.B.	Belgian Light Railways S.N.C.V.	Office des Transports Coloniaux O.T.R.A.C.C
		1	2	3	4	5
(a) Length of track laid on sleepers	km	5 645	167.2	53.7		27.3
	wood	1 693	52.6	46.7		
	concrete	3 613	108.8	7.0		
	steel	339	5.8			27.3
(b) Ratio between lines with L.W.R. and rest of system	%	13	2.3	0.7	50 (paved roads)	7.4
(c) Maximum speed over W.L.R.	km/h	140	120	140		60
(d) Maximum gross daily tonnage over L.W.R	tons	118 000	33 000	38 000		15 000
(e) Maximum temperature range	annual	90°	90°	85°	55°	55°
	daily	40°	45°	33°	15°	50°
(f) Number of sleepers per km	wood	1 667	1 533	1 555	1 390	
	concrete	1 667	1 533	1 555		1 500
	steel	1 667	1 533			1 500 to 1 750
(g) Type of fastening. Sleepers	wood	GEO	GEO	GEO	{ coachscrews { cramps	
	concrete	GEO	GEO	RN clips		RN clips
	steel	GEO	GEO-clips			GEO
(h) Kind of ballast under sleepers	wood	30/65	35/70	40/60		40/60
	concrete-steel	30/65	25/35	40/60		40/60
(i) Method of welding		Flash Thermit Secheron	Thermit Flash Arc	Flash Thermit Secheron	Thermit Arc	Thermit Flash
(j) Expansion devices		no	no	yes	yes	no
(k) Year when laying began		1949	1955	1950	more than 30 years	1956
(l) Quantity of ballast m³/km Sleepers	wood	3 270 (double track)	1 470	3 140 (double track)	600	
	concrete	2 880 (double track)	1 550	3 140 (double track)		700 to 800
	steel	3 635 (double track)	1 640			700 to 800
(m) Type of joint at ends of L.W.R.		normal	normal	expansion joint S.N.C.B.	normal	normal
(n) Use of bearing plates on sleepers	wood	poplar wood	poplar wood			
	concrete	poplar wood	rubber	rubber		rubber
	steel	poplar wood	poplar wood			

DENMARK	*SPAIN*	*FRANCE*			
Danish State Railways D.S.	*Spanish State Railways R.E.N.F.E.*	*French National Railways S.N.C.F.*	*Algerian Railways*	*Cameroons Railways*	*French Overseas Railways*
6	7	8	9	10	11
1.7	92	3 145	7.2	42	151
1.7	92				11
				42	140
	0.7	5		8	9
120	120	140	120	60	85
30 000	28 000	57 400	23 000	3 100	7 300
80° 40°	70° 35°	70° 43° 1 722	55° 35°	32° 25°	45° 35°
1 650	1 667	1 722 to 1 500	1 500 to 1 528 1 500 to 1 528	1 500 to 1 750	
RN clips	RN clips	RN claws RN clips	RN clips standard clips	clips, bolts	clips, bolts
30 70 Flash Thermit	30 50 Thermit	stone 20/60 slag 20/55 Flash Thermit	30/50 Thermit	40/60 Thermit	Thermit
yes 1952	yes 1955	yes 1949	yes 1952	no 1956	no 1951
2 500	g 2 120 (double track) g 3 820	1 500 to 1 350	1 200 to 1 500	600	830
expansion joint *D.S.*	expansion joint Martinet	expansion joint *S.N.C.F.*	S.N.C.F. Martinet	normal	normal
rubber	rubber	rubber rubber	rubber		

Half the system of the Belgian S.N.C.V. consists of rails laid in the roadway and welded together without any restrictions as to length.

As the data given in the table are too concise, we will make further comments on the information received from the different Administrations.

In the reply of the Italian State Railways (F.S.), rails laid in tunnels were not included in the mileage of L.W.R. because they consider that such rails have not the inherent characteristics of L.W.R. laid in the open air. In the case of the Austrian Railways, it was not specified whether rails in tunnels were or were not included in the 167.2 km of L.W.R.

1.2. *a*).

Of the 5 645 km of L.W.R. of the D.B., 805 km are laid with rails 120 to 1 000 m long and 4 585 km with rails more than 1 000 m long. In Germany, the longest L.W.R. section is 125 km and the double track line from Hamm to Bremen, 207 km long, includes 279 km of L.W.R.

The S.N.C.F. which is using L.W.R. for 60 % of its annual renewals has fixed the length of welded rails at 800 m and used expansion joints at the ends. The use of L.W.R. is general over the whole French system, and the longest section of track without joints is that from Orleans to Argenton-sur-Creuse, which is 170 km.

The *Belgian National Railways* (S.N.C.B.) like the S.N.C.F., uses the same length of rail — 800 m — and it is almost the same on the Spanish Railways (R.E.N.F.E.) since the average length of rail on their 92 km or L.W.R. is 1 000 m.

The Swiss Railways use rails of 700 to 1 200 m, and the Italians have 258 km of welded rails in their stations and on some viaducts none of which is more than 600 m long.

In the U.S.S.R. trials are now being made with 2, 13 and 5 km L.W.R., where the rails used are approximately 1 km long. On two of these L.W.R. the necessary arrangements have been made for the variation in length of the rails due to temperature changes to operate automatically. This system was invented by the Engineer *Botchienkoff*. On the third L.W.R. section, no longitudinal movement is allowed between the rails and the sleepers; twice a year, namely in the spring and autumn, the rails are freed from their fastenings to allow them to take up the length corresponding to the local temperature.

The Danish Railways like those of Luxemburg and Tunisia, all have under trial a rail about one kilometre long.

The sections of the Polish Railways laid with L.W.R. are made up of 660 and 720 m long rails, and it is intended to increase this length up to 4 000 m. The latter length is that of the trial rail of the Czechoslovakian Railways, who propose to make a 14 km long rail during 1958.

Finally, the Portuguese Railways have welded rails 600 m long on the Viana Bridge, and those of Algeria have some thousand kilometres of welded rails, the lengths of which vary between 30 and 114 m.

1.2 *c*) and 1.2. *d*).

The Table shows that with the exception of the metre gauge railways, on the other Administrations the speeds allowed on the L.W.R. vary between 100 and 160 km/h. This shows that no fears are entertained as to the safety of this new system of track, nor are there any as regards the amount of traffic carried, which on several sections, like the Cologne-Gromberg-Troisdorf run on the D.B., reaches 118 000 t a day on one track.

1.2. *f*).

The German, Austrian, Swiss and Czechoslovakian Railways have laid their L.W.R. without distinction on wood, con-

crete and metal sleepers. The French, Belgian and Polish Railways on wood and concrete sleepers; the Danish, Spanish, Dutch and Tunisian Railways on concrete sleepers; and the Italian, Portuguese and Swiss on wooden sleepers.

The Algerian Railways have put their L.W.R. on concrete sleepers and on steel sleepers, the Rhaetian Railway on wood and steel sleepers, and the African metre gauge Railways on steel sleepers.

In general, the number of sleepers per kilometre varies between 1 533 (65 cm spacing) and 1 667 (60 cm spacing). Only the U.S.S.R. Railways are an exception, with a much higher figure — 1 840 to 2 000 sleepers per kilometre.

The S.N.C.F., on their first class lines, lay them 58 cm apart — 1 722 per kilometre — and use the same number in the case of first and second class lines on concrete sleepers.

1.2. *g*).

Method of fastening: the two principal systems are the elastic type of fastening with RN clips invented and stipulated by the S.N.C.F., and the fastening with rigid clips and grooved plate, the type used on German « K » track. The two systems are used with wooden, steel and concrete sleepers. Figure 1 shows the French system of fastening on RS sleepers, and figure 2 on prestressed concrete sleepers or Laval longitudinal sleepers. Figures 3 and 4 show elastic fastenings for wooden sleepers, without bearing plate or with metal bearing plate. Figures 5, 6 and 7 show the German « K » system for concrete, wooden and steel sleepers.

Since paragraph 4.2 deals in detail with the methods of fastening used with L.W.R., we will not go into further details here.

1.2. *h*).

Most of the Administrations use broken stone and prefer the harder types of stone: ballast, granite, porphyry, etc., but also make use of hard limestones. The French and Luxemburg Railways also use broken blast-furnace slag and the Soviet Union has laid one of its L.W.R. on sand.

1.2. *i*).

Method of welding: it can be seen from Table 1 that thermit welding is largely used to make up L.W.R., but the Administrations who own flash welding equipment, use this method to make up their rails in the shops into various lengths which are then welded together in situ by thermit or arc welding.

1.2 *l*) and 1.2. *m*).

As the question « expansion joints » is amply dealt with in Chapter III, it is not necessary to give any further details here.

1.2. *n*).

The existence of grooved rubber bearing plates between the rail and the sleeper is an inherent part of the double elastic fastening of the S.N.C.F. — figures 1, 2, 3 and 4 — and consequently all the railways which use this type of fastening, use these bearing plates. The R.E.N.F.E use bearing plates with V-shaped grooves instead of the type with longitudinal grooves.

The Administrations using the German « K » type of fastening for rails — figures 5, 6 and 7 — use a poplar plate between the rail and steel bearing plate, with the exception of the S.N.C.B. where the rail is laid directly on the bearing plate (fig. 8).

The Luxemburg Railways use rubber plates between the rails and bearing plates when the L.W.R. are laid on wood sleepers and fastened by coachscrews (fig. 9). When concrete sleepers are used, the plate is put between the steel bearing plates and the upper part of these sleepers (fig. 10).

The Czechoslovakian State Railways only use rubber plates with concrete and steel sleepers. In the case of the former, they place the plate between the bearing plate

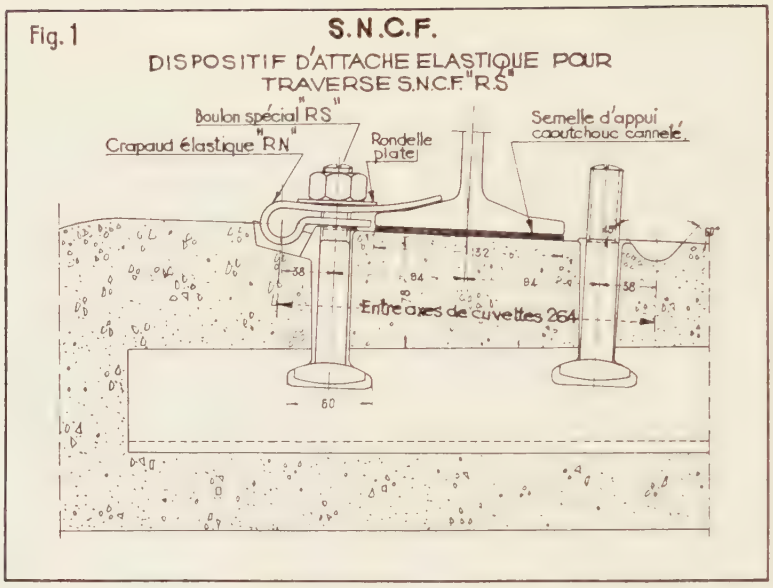


Fig. 1. — Elastic type fastening for S.N.C.F. « *RS* » sleepers.

N. B. — Boulon spécial « RS » = special « RS » bolt. — Semelle d'appui caoutchouc cannelé = bearing plate of grooved rubber. — Crapaud élastique « RN » = « RN » elastic clip. — Rondelle plate = flat washer. — Entre axes de cuvettes = distance between centres of spaces between sleepers.

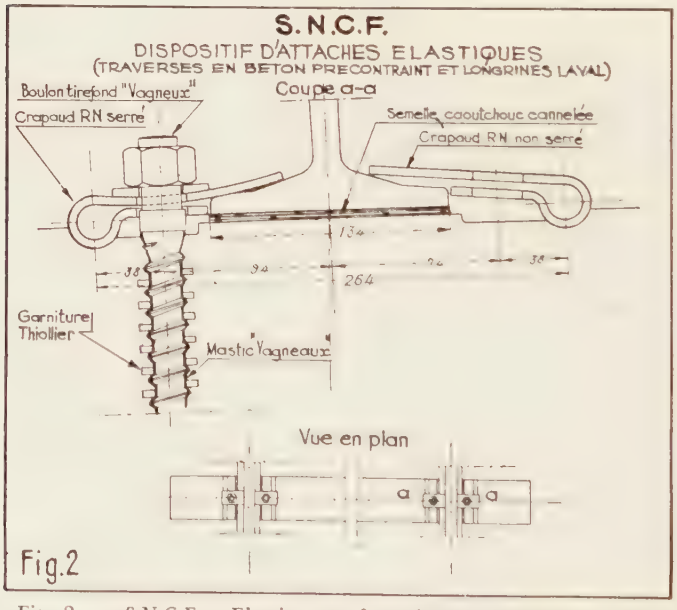


Fig. 2. — *S.N.C.F.* : Elastic type fastenings (Prestressed concrete sleepers and Laval longitudinal sleepers).

N. B. — Coupe a-a = section a-a. — Boulon tirefond « Vagneux » = « Vagneux » bolt coachscrew. — Crapaud RN serré = tight RN clip. — Semelle caoutchouc cannelée = grooved rubber bearing plate. — Crapaud RN non serré = loose RN clip. — Garniture Thiollier = Thiollier packing. — Mastic « Vagneux » = « Vagneux » putty. — Vue en plan = view in plan.

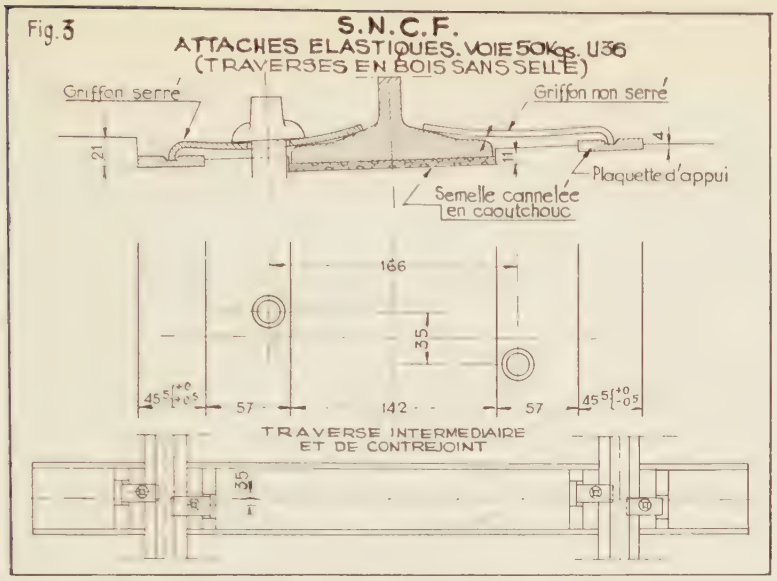


Fig. 3. — *S.N.C.F.* : Elastic fastenings. 50 kg track U 36. (Wood sleepers without bearing plate.)

N. B. — Griffon serré = tight grip. — Griffon non serré = loose grip. — Plaquette d'appui = support plate. — Semelle cannelée en caoutchouc = grooved rubber bearing plate. — Traverse intermédiaire et de contrejoint = intermediate and joint sleeper.

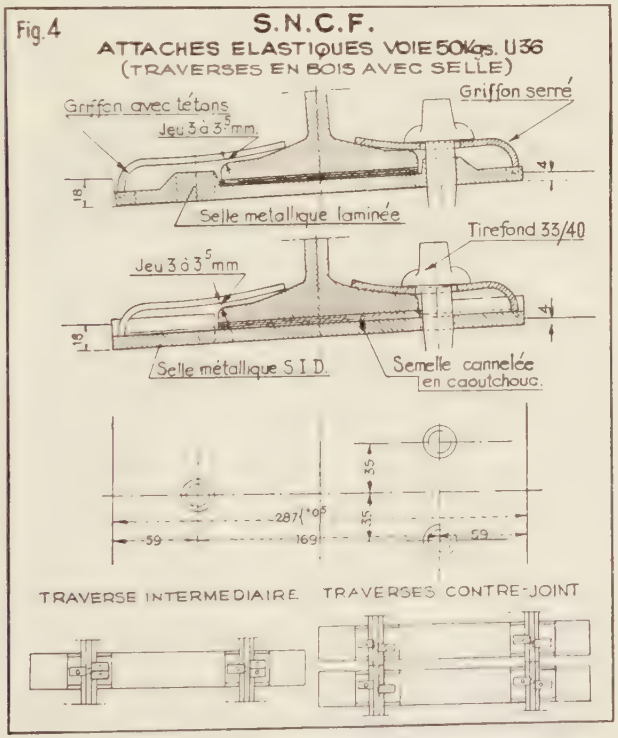


Fig. 4. — *S.N.C.F.* : Elastic fastenings, 50 kg track, U 36. (Wood sleepers with bearing plate.)

N. B. — Griffon avec tétons. Jeu 3 à 3.5 mm = clamp with centre point. Play 3 to 3.5 mm. — Griffon serré = tight clamp. — Selle métallique laminée = rolled metal bearing plate. — Tirefond = coachscrew. — Selle métallique S.I.D. = S.I.D. metal bearing plate. — Semelle cannelée en caoutchouc = grooved rubber plate. — Traverse intermédiaire = intermediate sleeper. — Traverses contre-joint = joint sleeper.

and sleeper, and in the case of the latter, between the foot of the rail and the top of the sleeper.

2. Usefulness of using long welded rails.

2.1. — *In order to obtain both better running and a decrease in maintenance costs, does your Administration consider that the best solution is to use L.W.R., or on the contrary, have you found by experience other equally satisfactory solutions? In the latter case, please give details of such solutions and the results obtained (see also question 5.4).*

on lines whose layout in plan allows it, i.e. where the radii of curves are not small.

Although the suppression of shocks at joints is an indisputable advantage of L.W.R., the Belgian Railways (S.N.C.B.) express the opinion, however, that the shocks at the joints on their system are not very important since they use 54 m long rails. It is the same for the Italian Railways who have only used L.W.R. in stations as they consider that the running on their lines has been extraordinarily improved since they adopted the 48 m long rail as standard and laid this with joints staggered by 12 m.

As regards the reduction in maintenance costs, all the replies also agreed in con-

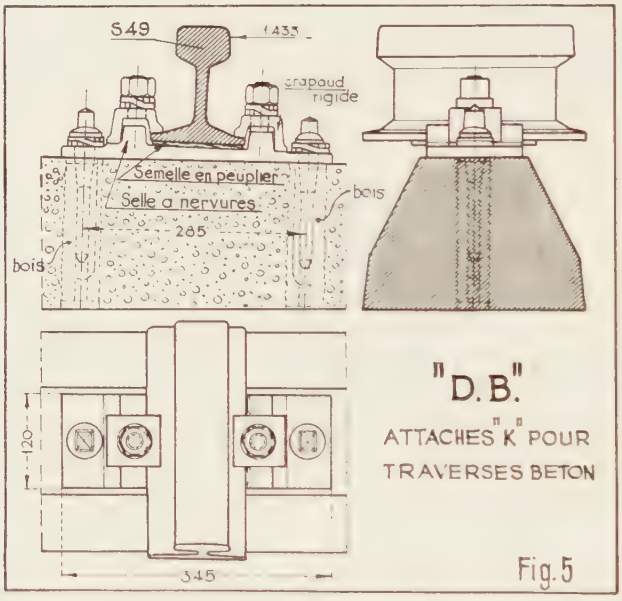


Fig. 5. — *D.B.* : « K » type fastening for concrete sleepers.

N. B. — Crapaud rigide = rigid clip. — Semelle en peuplier = poplar plate. — Selle à nervures = grooved bearing plate. — Bois = wood.

All the Administrations are agreed that from the point of view of the quality of running, the best solution is to use L.W.R. whenever possible. This can only be done

cluding that the best solution lies in using L.W.R. since in this way, there is a saving of the considerable cost involved in maintaining the level of the joints, and in

broken rails which so frequently occur at the fishplating. However, add the Swiss Railways — in drawing up the balance sheet for maintenance costs for L.W.R. the inspection and extra care needed with this new type of track must not be overlooked.

whether they have any influence on the formation of undulatory wear. If this depends — as the D.B. affirm in their reply — on the nature of the metal, naturally they have no influence on it at all.

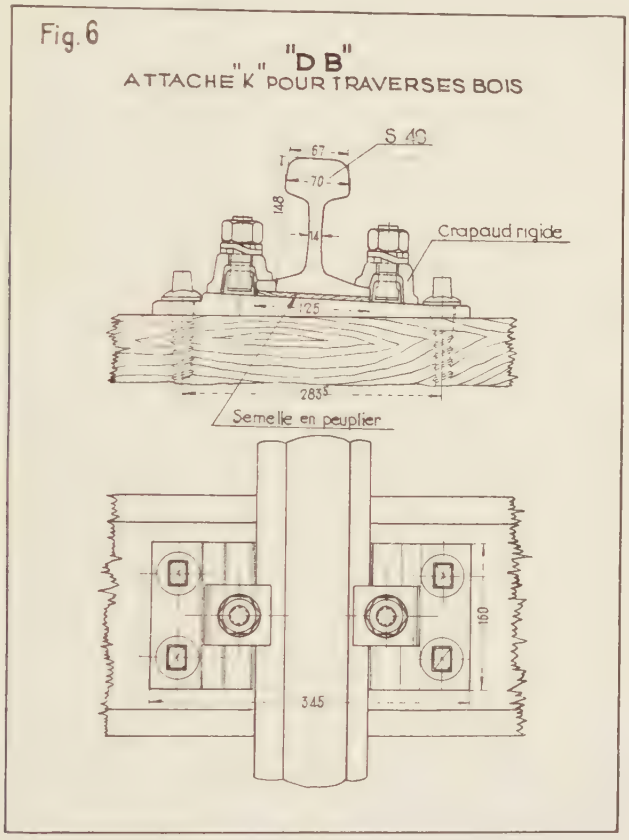


Fig. 6. — *D.B. :* « K » type fastening for wood sleepers.

N. B. — Crapaud rigide = rigid clip. — Semelle en peuplier = poplar plate.

2.2. — *Have you found that there is any improvement, however small, in undulatory wear on sections laid with L.W.R.?*

All the Railways consider that experience of L.W.R. is still too recent to decide

In the case of the first trial L.W.R. laid by the R.E.N.F.E. with Thomas rails, undulatory wear immediately appeared. This was not repeated in the case of the remaining L.W.R., which were made with Bessemer and Siemens-Martin rails.

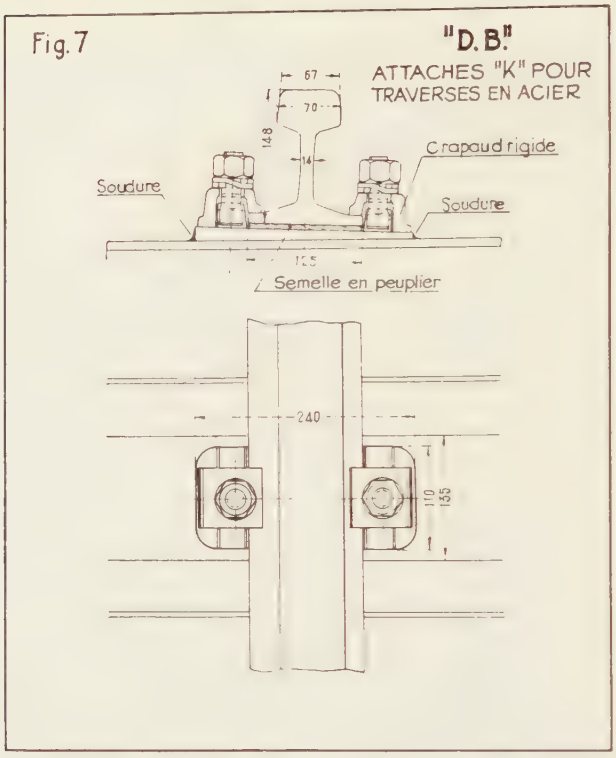


Fig. 7. — *D.B.* : « K » type fastening for steel sleepers.

N. B. — Crapaud rigide = rigid clip. — Soudure = weld. — Semelle en peuplier = poplar plate.

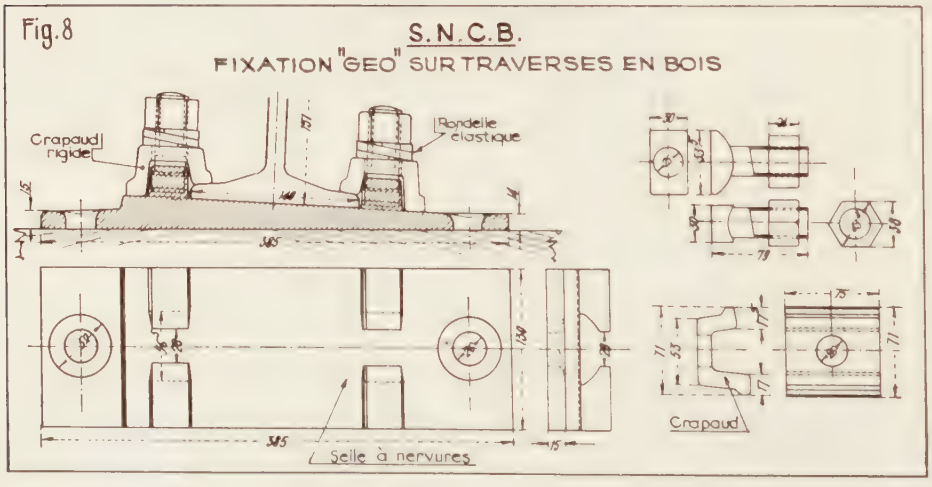


Fig. 8. — *S.N.C.B.* : « GEO » type fastening on wood sleepers.

N. B. — Crapaud rigide = rigid clip. — Rondelle élastique = elastic washer. — Selle à nervures = grooved bearing plate. — Crapaud = clip.

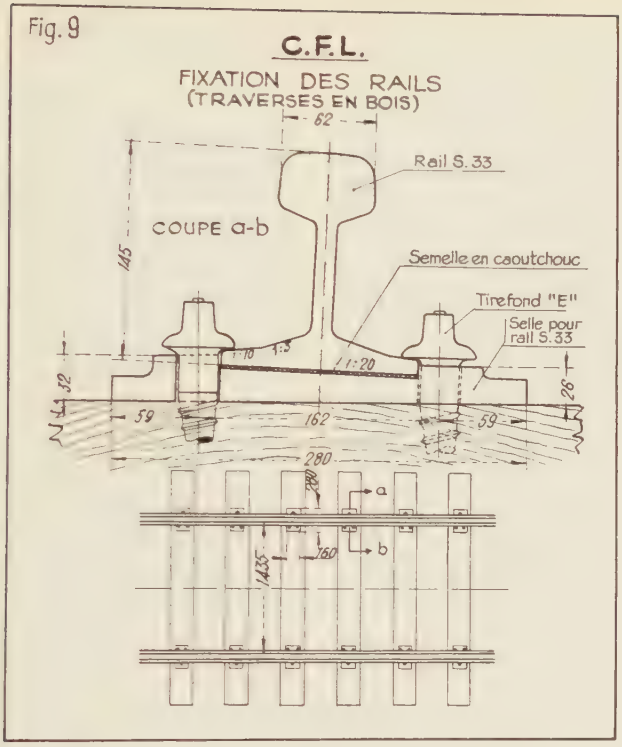


Fig. 9. — *C.F.L.* : Rail fastening (wood sleepers).

N. B. — Coupe a-b = section a-b. — Semelle en caoutchouc = rubber bearing plate. — Tirefond « E » = « E » coachscrew. — Selle pour rail S. 33 = bearing plate for S. 33 rail.

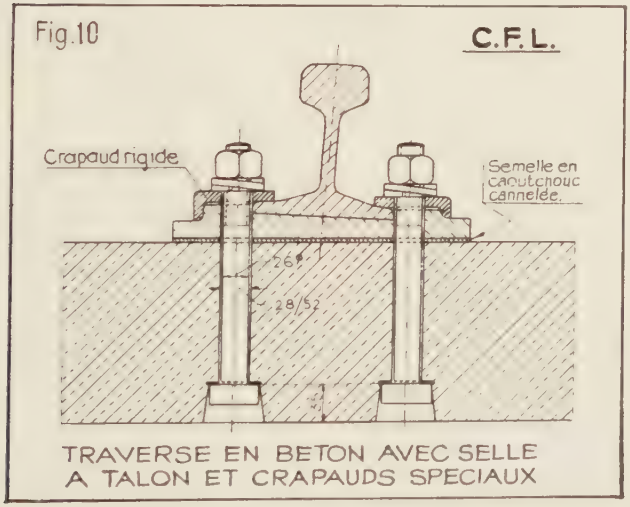


Fig. 10. — *C.F.L.* : Concrete sleeper with claw bearing plate and special clips.

N. B. — Crapaud rigide = rigid clip. — Semelle en caoutchouc cannelée = grooved rubber plate.

3. Manufacture of long welded rails.

3.1.1. — *What methods of welding does your Administration use to make L.W.R.?*

The two Administrations who have the greatest experience of L.W.R. — the German D.B. and French S.N.C.F. — first of all weld their rails by flash butt welding in the shops into 120 m lengths in Germany, and 300 m lengths in France. These rails are then taken to the place where they are going to be used and welded there into long rails by thermit welding in France, and by thermit or Secheron welding in Germany. The D.B. only use the latter method on a very small scale, since only 7 to 8 000 Secheron welds are made every year compared with 150 000 thermit welds.

The Belgian Railways (S.N.C.B.) and Swiss (C.F.F.) make their long rails in a similar way, flash butt welding in the shops — into 216 m lengths in Switzerland — and thermit or Secheron on the line.

The Ö.B.B. use flash butt welding in the shops in order to make up 45 m lengths, exceptionally 60 m, by welding together old rails. These are made up into L.W.R. on the line by thermit welding.

The Czechoslovakian Railways use fixed or mobile plant to flash butt weld and the Polish Railways make 240 m lengths by flash butt welding in the shops, which are then arc welded on the line.

Thermit welding is used exclusively by several Railways: Danish, Spanish, Dutch, Italian and those of Africa: Matadi-Leo, Cameroons, Dakar-Niger, Algerian and Tunisian.

On the S.N.C.B. (Belgium), in addition to thermit welding, arc welding is used by inserting a vertical plate between the rail ends, and arc welding is also used on the Luxemburg Railways (S.N.C.L.), Portuguese (C.P.) and in the Soviet Union.

3.1.2. — *With which method have you obtained the best results?*

Those Administrations which make use of several methods of welding, such as the German, Austrian, Belgian (S.N.C.B.), French (S.N.C.F.), Polish, Swiss and Czech, agree that the best results are obtained with flash butt welding. The D.B. in fatigue tests — Wöhler curve — obtained with this process stresses of 28 kg/mm² compared with 32 to 34 kg/mm² in the case of test pieces from unwelded rails.

By using automatic machines for flash butt welding, the D.B. gets results with minimum dispersion, as well as practically no breakages, 1.5 to 3 for 100 000 welds, whilst with the same number of welds using the thermit process, the number of breakages varies between 10 and 18. The cost of the three types of welds on the D.B. flash butt, thermit, and Secheron are in the ratio — 1 : 1.5 : 2.

In the Soviet Union, the L.W.R. are made by electric welding only, as this Administration considers that welds made by other methods are of inferior quality.

3.1.3. — *In carrying out such welding, have you any technical specification, especially as regards recording certain methods of detecting defects?*

Some Administrations have prepared technical welding specifications dealing mainly with the manner of carrying out the operation of welding, but not containing any clauses concerning the quality of the welds and the most that is done is to prescribe bending tests, Brinell ball-testing, metalographical examinations, etc.

The German and Swiss Railways have reduced to the minimum defects in flash butt welding by means of special equipment which they fit on the welding machines which record the characteristics of the operation: intensity of current, pressure applied at welding and direction of application.

The same Railways have used ultrasonic equipment to detect flash butt welding defects, but the same could not be done in the case of thermit welding owing to the difficulties which arose.

The Czechoslovakian Railways use magnetic detectors in the case of welds made in the shops.

The checking of welds made on the line is done visually and is limited to supervision of the welding operations and proper training of the staff.

3.2. — *If the method of welding used involves adding steel, what differences are there between the steel used for the rails and this added steel, the object in view being to avoid the production of hollow surfaces or bumps on the running surface near the welds after a certain time?*

If the method of welding used does not involve the addition of steel, have you found that there are any changes in structure in the welded zone likely to give rise to the same type of defect? If so, have you found any way of preventing this?

In the case of welds on rails made by the Administrations who use flash butt welding, the defects mentioned in the above question have not occurred.

In the case of railways using thermit welding, the results obtained as regards the formation of bosses and depressions vary. Whilst in the case of the thermit welding of the German, Belgian, Danish, Spanish, French and Algerian Railways such defects have been noticed, on others such as the Cameroons, Dakar-Niger and Netherlands, they have not.

In general, all the Administrations recommended that the steel used for thermit welds should be a little harder than that used for the rail; according to the D.B., by 10 to 20 Brinell units, and according to the S.N.C.F. it should not exceed 50 units. Recently, the quality of the weld metal has been considerably improved and the formation of depressions has been almost eliminated.

When arc welding is used, the C.F.F. advise that the preheating be maintained for the whole period of the operation. The German Railways also recommend that the added metal from the electrodes should have a higher traction strength than that of the rail metal. However, the Czechoslovakian Railways use electrodes having a tensile strength of 55 kg/mm² for 65 to 70 kg/mm² rails, and the Polish Railways 55 to 70 kg/mm² for rails having a similar tensile strength. The electrodes used by the S.N.C.F.L. are of chrome-nickel-molybdene steel.

Whilst no depressions have occurred in the welds made by arc welding by the Czechoslovakian and Polish Railways, the Rhaetian Railway who uses the same method of welding, has found that bosses form.

3.3. — *Whatever kind of welding is used, do you consider that it is useful, or at least advisable, to heat-treat, anneal or normalise the welds?*

The flash butt welds of the German, Austrian, Belgian, French, Swiss and Czechoslovakian Railways are not given any heat treatment; on the other hand, the Polish Railways consider it is better to heat the welds to a temperature of between 500° and 600° C., i.e. below the lower point of transformation of the rail steel.

With the exception of the Algerian Railways, the Belgian Light Railways and the Matadi-Leo, those using thermit welding do not subject the welds to any kind of heat treatment : annealing or normalization, a practice given up by those who used to make use of it. The Algerian Railways continue to employ both methods, with or without annealing, and the statistics for breakages in service do not show any appreciable difference between the two methods.

The Belgian S.N.C.V. think that annealing is advisable although not necessary, and the opinion of the Matadi-Leo is that it should be used.

The German, Russian and Czechoslovakian Railways state that welds made by arc welding should be heat treated afterwards depending on the operating method used. According to the U.S.S.R. Railways annealing by means of gas burners or electrothermic methods is the best way of obtaining quality welds. Neither the Luxemburg Railways nor the Rhaetian Railway anneal their arc welds.

3.4. — *In order to prevent noise arising at welded joints similar to — though on a much reduced scale — that produced at fish plated joints, do you enforce any precise regulations concerning the tolerances allowed in lining up both in level and on the cross section, the welded joint being rejected where such tolerances are exceeded?*

All the replies agreed that the weld should be made as perfectly as possible, in order to avoid any appreciable difference between the surfaces of the weld which will be in contact with the tyres and the surfaces of the rail itself which are beyond the reach of the work of grinding or filing.

The tolerances allowable are similar on the different railways, but the most precise are those of the C.F.F. Although they endeavour to obtain a better finish, they allow the following tolerances:

in height:

0.5 mm measured over 1.5 m.
0.3 mm measured over 0.2 m.

laterally:

0.75 mm measured over 1.5 m.
0.50 mm measured over 0.2 m.

The D.B. allows differences of not more than 1 mm provided they disappear on each side within a distance equal to 500 times their value.

On the S.N.C.F. and R.E.N.F.E., the tolerance is 0.5 mm measured with a metre straight edge; in Holland, the tolerance is 0.2 to 0.3 mm in height on a straight edge of 0.6 m and in level 1 mm; with the same straight edge; in the U.S.S.R., it is 0.5 mm measured over 0.2 m and in Algeria 1 mm measured over 1.5 m.

Some Railways are of the opinion that it is possible to apply more severe tolerances by using mechanical grinding machines.

3.5. — *What is your opinion concerning the most suitable length for L.W.R. from the technical, economic and practical points of view?*

In order to arrive at this length, have you taken as a basis theoretical considerations or only practical considerations?

In the first case, please give the hypotheses used, the maximum temperature variations allowed for, and the form of calculation used.

From the theoretical point of view, all the Administrations are agreed that there is no limit to the length which L.W.R. can be made.

On the other hand, practical considerations have led the Administrations who can be considered the pioneers of the L.W.R. to adopt different solutions. In fact, the German Rys. have made rails several km long, and on the contrary, the S.N.C.F. have adopted as the standard length 800 m long rails with expansion joints at the ends, which makes it easy to lay them in the track and repair them quickly in case of breakages.

The same standard length has been adopted by the S.N.C.B. who used similar reasons to those of the French National Rys. as its basis.

The rails laid by the R.E.N.F.E. are somewhat longer, as their average length is 1 000 m.

On the Netherlands Rys. the L.W.R. cannot exceed 1 500 m on account of the block sections.

The C.F.F. are of the opinion that the length of rail should be so chosen that

two rails can be laid simultaneously on the track in intervals between trains, and that it should also be possible to carry out regulation of the stresses without hindering the train working. Although they have based their calculations upon studies made by MM. Meyer (1) and Martinet (2), they consider that the theories given therein are only of relative value today on account of their simplified hypotheses.

Theoretical and practical calculations have led the Soviet Union to use 1 000 m long rails on their type of track with automatic expansion according to the temperature.

As for the Algerian Rys., they stipulate a length for L.W.R. of between 700 and 1 000 m. The other African Rys. consider that L.W.R. should be as long as possible. Thus, the Cameroons and French Overseas Rys. have welded their rails from one station to the next as a result of the experience acquired over three years by this latter Administration with 1 000 m long rails.

3.6. — *What is the smallest radius of curve on which you consider it is possible to use L.W.R.?*

Is this limit determined by theoretical studies, or prudence, or have you learnt by experience what limits must not be exceeded?

In general it can be stated that the radius of curve for which L.W.R. can be used, constantly decreases as experience is acquired concerning the behaviour of jointless track and the phenomena inherent in expansion limited by the friction of the sleepers on the ballast become better known.

As a result of experience and theory, the D.B. has laid L.W.R. at the present time on track with curves equal to or exceeding 500 m. For curves of between 300 and 500 m radius, the resistance to lateral displacement must be increased by special clips with anchoring feet and the fastenings tightened up at a temperature of more than 10° C. approx. above the average temperature during the year. In such cases, it is useful to ram or compress the ballast under the sleepers by mechanical means. On tracks of secondary importance in stations situated between other tracks, long rails can be welded on curves of 190 m radius.

In the case of the S.N.C.F., considerable experience has confirmed that in the case of welded track laid on wood sleepers at 60 cm intervals and fitted with double elastic fastenings, it is possible to go as low as curves of 800 m radius even for very high speeds and temperature differences of ± 40° C. compared with the temperature at which the rails were laid.

As a result of lateral resistance tests carried out with the derailing wagon of the S.N.C.F., it was found that this resistance, in the case of track laid on RS concrete sleepers or *Laval* longitudinal sleepers was definitely higher and more regular than in the case of track on wood sleepers, and consequently on such track it is possible to extend the use of L.W.R. to curves of 500 m radius. This figure must be taken as provisional since it is possible that this value can be reduced to a lower figure, as has already been done on a line with nothing but freight traffic, on which L.W.R. have been laid on curves of 350 m radius.

The minimum radius limits laid down by the Austrian Rys. in their provisional specifications for laying track without joints are 1 000 m in the case of curves on track laid on wood sleepers and 500 m on track laid on concrete or steel sleepers.

When the radii of curves are between 3 000 and 1 000 m the Belgian Rys. install — as a precaution — an expansion device at each end.

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(1) H. Meyer : « Die Stabilität des luckenlosen Vollbahngleises » - V.D.I. - 1934-4.40. « Kräfte und Spannungen im Langschienen-Oberbau - V.D.I. - 1935.H.12. « Vorschlag zur Verlegung eines Langschienengleises ». « Organ », 1936-H-19.

(2) A. Martinet : Warping of jointless track on ballast and long rails. « Revue Générale des Chemins de fer », Oct. 1936.

The R.E.N.F.E. has already laid L.W.R. on curves of 600 m radius and even less, and is considering going down to the limit of 500 m selected by the S.N.C.F.

This radius has also been accepted as the minimum by the U.S.S.R. Rys. who have already tried with success L.W.R. 1 000 m long on 500 m radius curves.

The Polish Rys. who have some L.W.R. on curves of 1 000 m, consider that it would be possible to go as low as 600 m without inconvenience, and the Italian Rys. have laid L.W.R. on a viaduct on a curve of 600 m radius.

For the Swiss Rys., the minimum radius prescribed for 46 kg/m rails laid on wood, steel or concrete sleepers, at 60 cm intervals is 800 m, and in special cases they have gone as low as radii of 600 m. This radius has been selected for theoretical reasons, but it is thought that it will be still further reduced if the trials now in hand prove satisfactory.

The Algerian Rys. who so far have only laid L.W.R. on straight sections and on curves of 1 500 m radius or over, arrange their L.W.R. in such a way that curves and special points on the line — small metal bridges, level crossings — are as far as possible in the central third of the L.W.R. or more than 100 m from the free joints, so as to avoid concentrations of stresses in the parts in movement.

The radii allowed by the African Rys. are much smaller than those mentioned above; for ex. the Matadi-Leo Ry. has already laid L.W.R. on curves of 200 m radius and is expecting to go as low as 145 m, the smallest radius curve on its lines. In the same way, the Cameroons Rys. have welded their lines with curves of 120 m radius with satisfactory results.

The Dakar-Niger Ry. after having begun in 1952 to lay its L.W.R. only on curves of 1 000 m, having regard to the results obtained, in 1955 welded a 350 m radius curve without any deformation having occurred to date.

3.7. — *If there are many straight lengths on a section of a line suitable for L.W.R. and at the same time curves whose radius is below the admissible limit mentioned under point 3.6 above, what is the maximum length of rails used by you?*

In such a case do you consider it better to lay the rails with the joints staggered rather than opposite each other?

In general L.W.R. are laid on straight sections and curves of sufficient radius, whilst on the other curves of small radius, the standard lengths of rail used on the system in question are laid.

On the D.B., for example, the maximum length of such rails is 45 or 60 m; on the S.N.C.B., 54 m; in Italy 48 m; on the S.N.C.F., R.E.N.F.E. and in Tunisia 36 m; in Austria 30 m and in Czechoslovakia, 25 m.

The Algerian Rys. lay their 72 m long welded rails on curves of 750 m or over when the sleepers are concrete and go down to 500 m radius if the sleepers are steel. The length of 36 m has also been widely tried on radii of 300 m without inconvenience, with both steel and concrete sleepers.

On straight sections or curves of more than 1 000 m radius on wood sleepers, the S.N.C.F. use elastic type fastenings without bearing plates (fig. 3) and on curves of less than 1 000 m radius metal bearing plates are used (fig. 4).

For theoretical reasons, the Belgian Rys. do not use lengths of rails longer than 1/11th of the radius on curves of less than 1 000 m radius.

Regarding the use of in line or staggered joints on curves, opinions differ considerably. The Algerian, Spanish, French and Italian Rys. prefer staggered joints to avoid irregularities in the curvature and improve the running. Germany also inclines towards this tendency and in 1955 laid some sections of track with staggered joints, and although it is not long enough for a final judgement to be made, they can already state that track laid in this way retains its layout better than when the joints are in line.

On the contrary, the Ö.B.B., S.N.C.B.,

C.F.F. and Czechoslovakian Rys. use joints in line, and Switzerland considers that staggered joints can only be advantageous on curves of small radius and on service sidings.

On curves of radii between 300 and 500 m laid by the R.E.N.F.E. with 30 m rails on RS concrete sleepers, with joints staggered by 12 m, the lateral thrust exerted by vehicles on the outer rail has caused the foot of the rail to get between the fingers of the RN clips, which has led to its permanent deformation. To avoid such plastic deformation, on the top finger of the clip a reinforcing plate of the same steel has been added. In this way, the clip forms a two bladed spring and so far the results have been extremely satisfactory.

3.8. — *Do you consider it necessary to use expansion devices at the ends of L.W.R., enabling the ends to move to a certain extent? If so, have you found that after a certain time in service these had to be re-set owing to abnormal internal stresses developed in some central portion of the rail? If so, what do you do?*

If on the contrary you do not consider it necessary to use an expansion device at the ends of L.W.R. allowing the normal joint gap to be exceeded — about 20 mm — has practical experience confirmed you in this opinion or have any disadvantages been experienced with these rails so that in the future you will use expansion devices able to allow more movement?

Opinions concerning the need to have expansion equipment at each end of L.W.R. or not differ in the two countries — Germany and France — who have thousands of miles of L.W.R. Whereas the S.N.C.F. considers it necessary to use specially designed expansion devices giving a large possibility of expansion — 18 cm — without risk of wedging, whilst assuring the continuity of the rails at the ends of the L.W.R. where the joint gap may be several centimetres, the D.B., according to the experience it has acquired over several years, considers that the use of such apparatus is not essential.

The German opinion is based on the fact that the L.W.R. only expand over a length of 30 to 40 m at each end, and a normal fishplate joint giving a possibility of expansion of 20 mm is sufficient between — 30° and + 60° C. (1), as according to the D.B. the maximum gap noted in rail breakages was 30 mm. Of these 20 mm, 5.5 mm used the « traction » side, 7.5 mm the compression side, and 7 mm for the fishplated track. The D.B. considers that in order to do away with expansion joints it is necessary to have a good bedding in the horizontal plan of the rails on the sleepers, which is assured if there are anti-creep devices over a length of 50 m at each end (fig. 11) and if suitable ballast is used.

The Administrations consulted are divided equally on the choice of one or other tendency. As Table I shows, the S.N.C.B. (fig. 12), the Danish State (fig. 13), R.E.N.F.E. (fig. 14), S.N.C.F. (fig. 15), S.N.C.L. (fig. 16 and 17), Algerian Rys., Netherlands Rys. (fig. 18), U.S.S.R. (fig. 19), C.F.F. (fig. 20) and Tunisian Rys. have adopted the criterion of ending the L.W.R. by expansion joints, whilst the D.B., Ö.B.B., Matadi-Leo Ry., Cameroons Rys., French Overseas Rys., Italian, Polish, Czechoslovakian and Rhaetian Ry. consider that it is not necessary to use expansion joints. The Italian Rys. use expansion joints (fig. 21) at the approaches to steel bridges.

Except for the Polish Rys., these Administrations do not think they will use them in the future.

As regards the jointless track of the U.S.S.R., whose longitudinal displacement is regulated twice a year, the expansion joints can be replaced by a series of rails of different lengths.

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(1) Rubin : « Betrachtungen über Stosslücken im Gleis », « Der Eisenbahningenieur », 1955, Heft 2.

Wattman : « Längskräfte im Eisenbahngleis », Otto Elsner Verlag, 1957, Seite 155.

Some railways like the C.F.F. which usually use expansion joints, no longer do so in the case of rails laid in stations when the lengths are between 300 and 600 m, seeing that the stability of such track is generally better on account of the higher resistance to lateral movement, and the track is permanently under the eyes of the station staff.

The Swiss also think that the ordinary

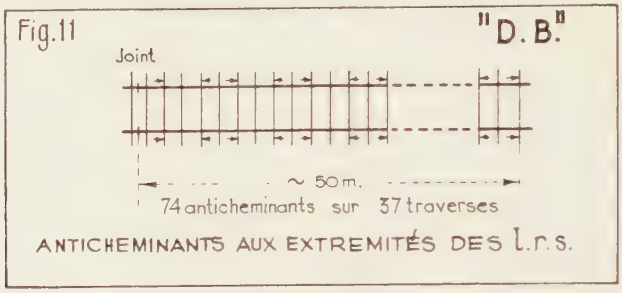


Fig. 11. — *D.B.* : Anticreep devices at ends of L.W.R.

N. B. — Joint = joint. — 74 anticheminants sur 37 traverses = 74 anticreep devices on 37 sleepers.

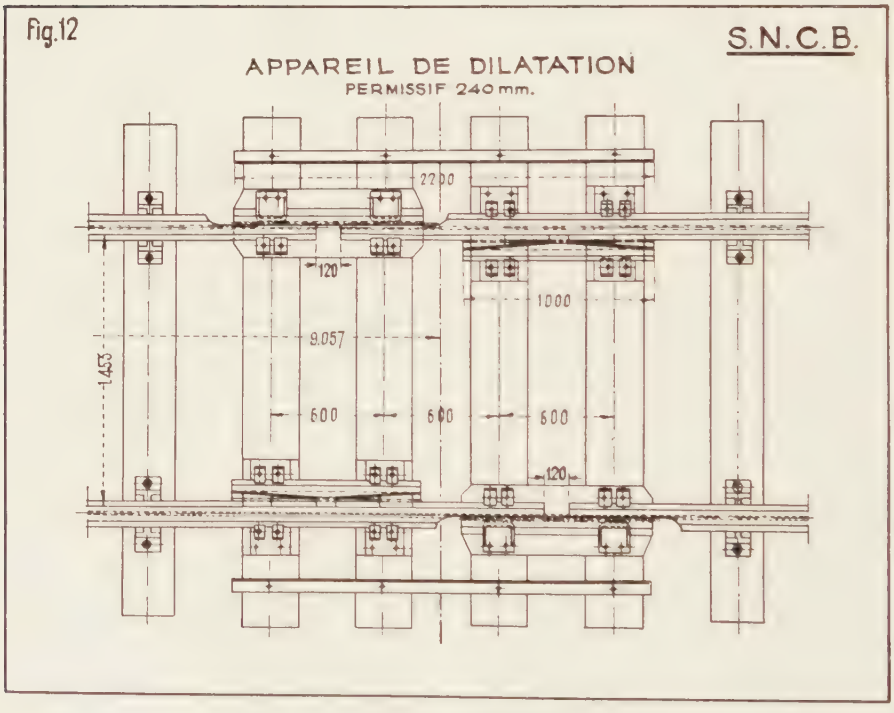


Fig. 12. — *S.N.C.B.* : Expansion equipment.

N. B. — Permissif 240 mm = permissive gap 240 mm.

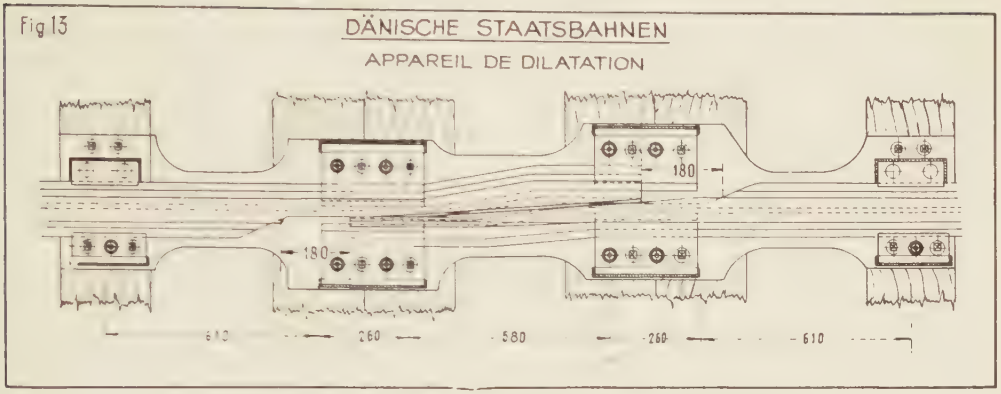


Fig. 13 — *Danish State Rys :* Expansion device.

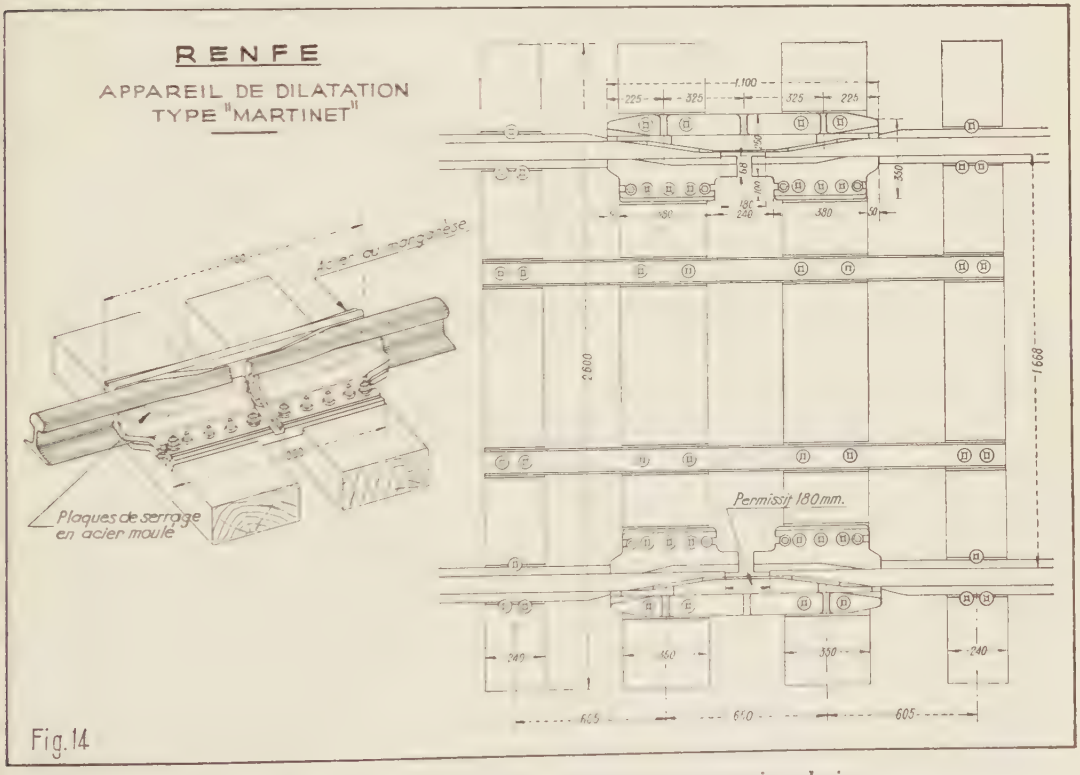


Fig. 14. — *R.E.N.F.E. :* « Martinet » type expansion device.

N, B. — Acier ou manganèse = steel or manganese. — Plaques de serrage en acier moulé = Tightening up plates in cast steel. — Permissif 180 mm = permissive gap 180 mm.

joints at the ends of jointless track do not appear to have any major drawbacks. This opinion is also held by the U.S.S.R., on condition that the normal joints are so designed as to remedy the most important longitudinal deformations.

On the contrary, the Polish Rys., who have not used expansion joints, are thinking of trying them although there have not been any serious drawbacks from joining up their L.W.R. with the standard 30 m long rails. Only in one case with temperatures of — 36° C. did the fishplate bolts become deformed and had to be replaced.

The expansion joints laid by the above

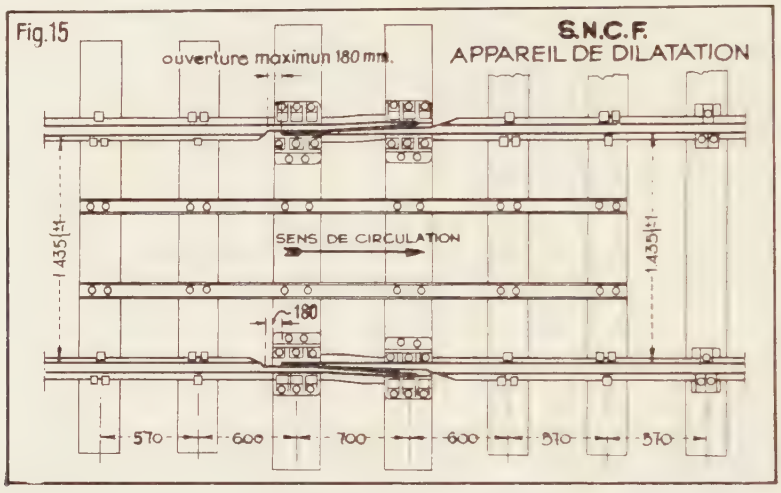


Fig. 15. — *S.N.C.F.* : Expansion device.

N. B. — Ouverture maximum 180 mm = maximum gap 180 mm. — Sens de circulation = direction of trains.

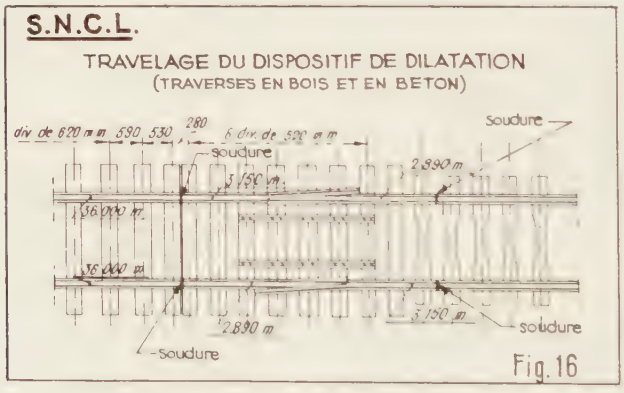


Fig. 16. — *S.N.C.L.* : Sleepering used with expansion device. (Wood and concrete sleepers.)

N. B. — Soudure = weld.

mentioned Administrations have not required any subsequent adjustment, except when laying took place at a temperature below the average, or when the stresses were relaxed before the first hot period.

In the opinion of the S.N.C.B., except when there is very quick and very considerable variation in temperatures, the stresses in absolute value are lower than over a year of the switch points did not exceed 30 mm and in most cases was only about 20 mm.

On the other hand, on the R.E.N.F.E. the opening between the noses of switches in the centre of Spain varied between 152 mm in winter to 57 mm in summer.

On the Matadi-Leo Ry., which considers that expansion joints are unnecessary, all

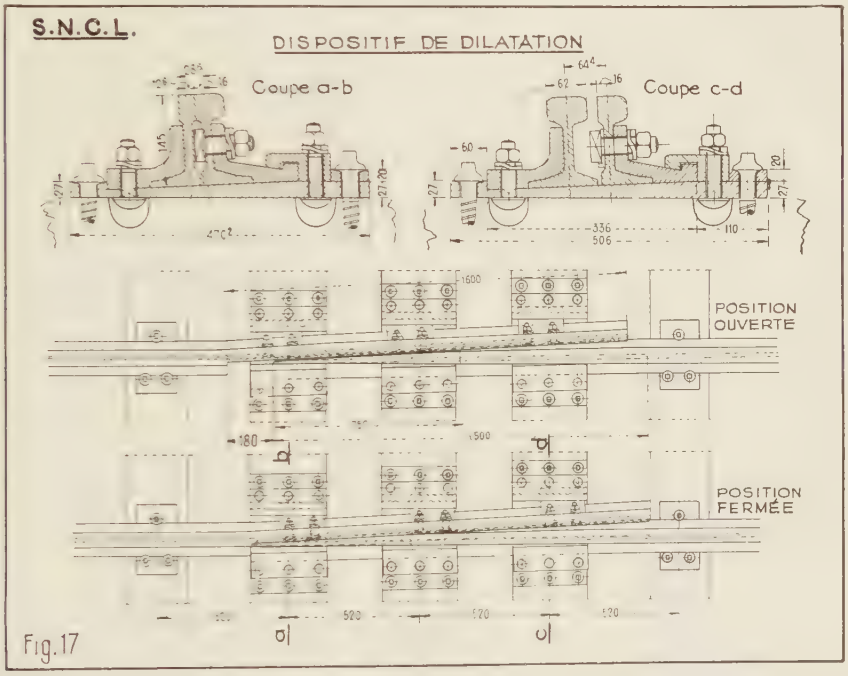


Fig. 17. — *S.N.C.L.* : Expansion device.

N. B. — Coupe a-b = section a-b. — Position ouverte = open position. — Position fermée = closed position.

those given by the calculations. It appears that under the effect of vibrations due to the passage of trains, compensation of the stresses occurs, seeing that there are always two free ends and consequently the stresses gradually fall towards zero.

Although the expansion devices allow of considerable expansion, displacements during the course of the year are not very great. Thus the Algerian Rys. have found that with metal sleepers, the displacement

the isolating wood fishplates that were laid on sections where electric signalling is being installed, recently broke. These breakages occurred in spite of the fact that the precaution had been taken of inserting between the isolating fishplate joints and the L.W.R. a 15 m rail fishplated to the adjoining L.W.R. This proves that the Swiss criterion of relieving isolating joints by suitable methods : anticreep devices, blocking, etc., is well founded.

3.9. — *What type of expansion device is used on your railway? Please join drawing.*

What is the cost of this device compared with the length of track it takes up?

What expansion limits have you adopted?

What is the effect of the cost of expansion devices on the cost of a kilometre of running line?

Same question in the case that you do not use expansion devices but make use of certain special devices — anticreep devices for example — with your L.W.R. Please join drawing of joints and special devices.

In figures 11 to 19 are shown the expansion joints used by the various Administrations, with an indication of the maximum permissive opening.

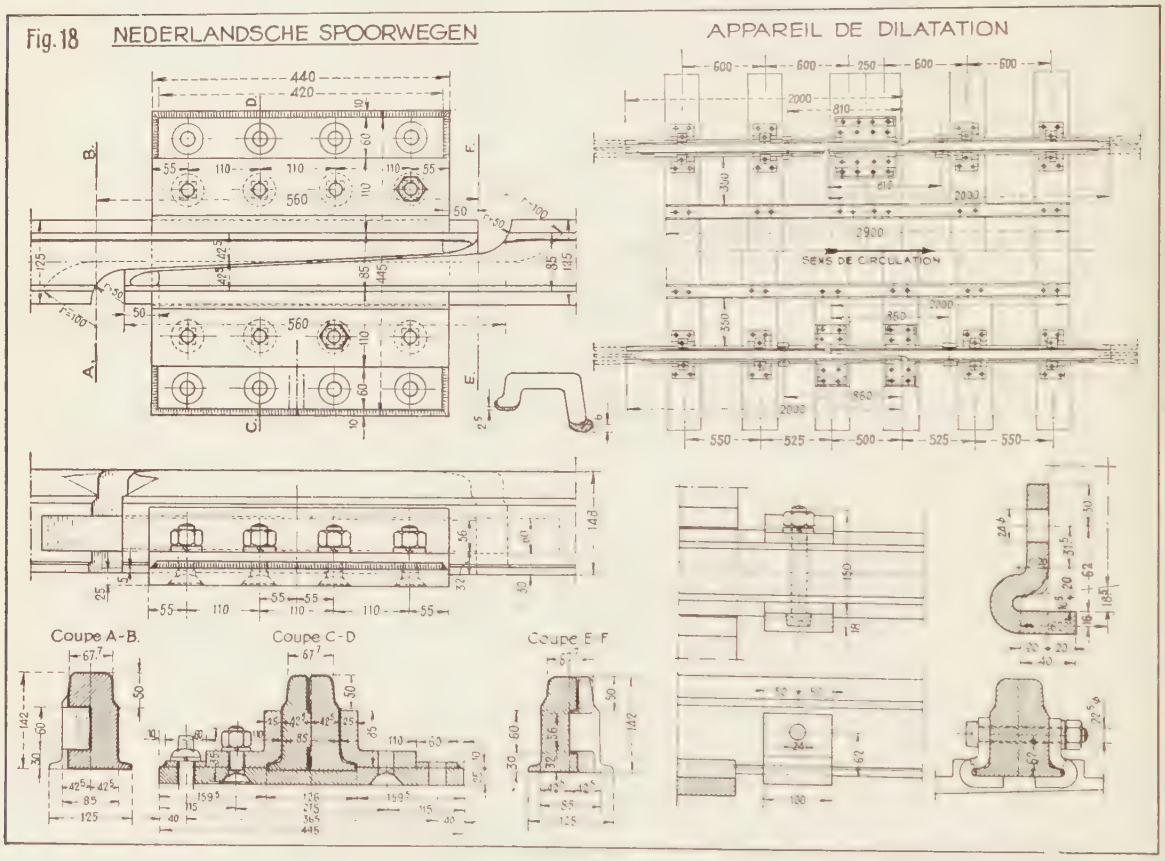


Fig. 18. — *Netherlands Rys.* — Expansion device.
N. B. — Sens de circulation = direction of traffic.

On the R.E.N.F.E. the MARTINET (retired Engineer of the S.N.C.F.) type of expansion joint (fig. 14) is used both on track with 45 kg/m rails and those with the 54 kg/m UIC rails.

In Russia, a very wide opening is allowed: 878 mm since in 24 h the variation

at the end of L.W.R. may be as much as 220 mm and the annual variation 500 mm with a temperature range of 100° C.

The cost of such equipment compared with the cost of the track which it replaces and the cost of the equipment compared with that of one kilometre of track are shown in the following table :

	Cost of equipment compared with the cost of the length of track which it replaces	*Cost of equipment compared with the cost of one kilometer of track, in %*
BELGIUM	1.26	0.46
SPAIN	1.90	0.72
FRANCE	2.5	1.00
ALGERIA	—	1.0 to 1.5
HOLLAND	-	2.5
ITALY	5.0	5.0
U.S.S.R.	3.14	6.7
SWITZERLAND	4.8 to 7.5	1.7 to 2.7

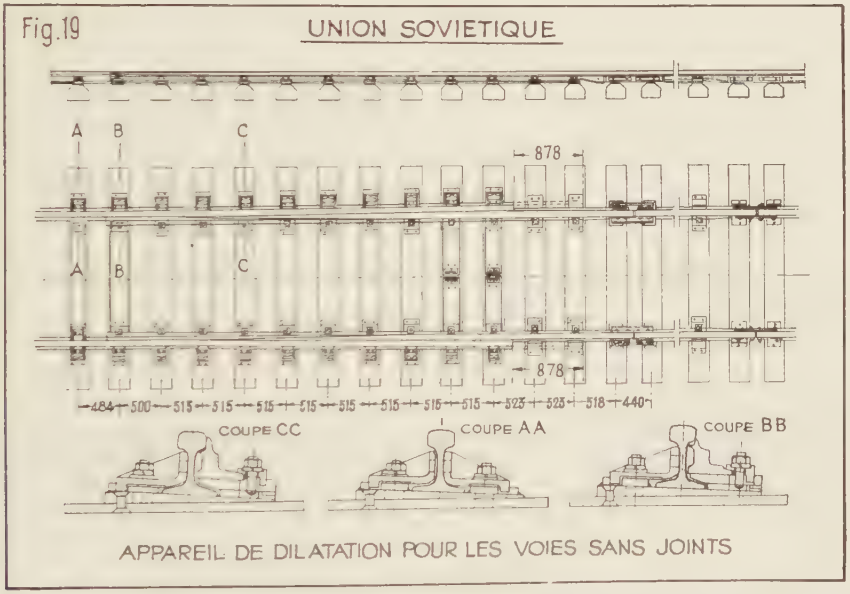


Fig. 19. — *Soviet Union :* Expansion device for jointless track.

4. Laying long welded rails.

4.1.1. — *Amongst the types of sleepers used — wood, metal, concrete — which do you consider most suitable for use with L.W.R.?*

Most of the Railways agree that track laid on concrete sleepers owing to its weight is particularly suitable for L.W.R. Even in certain countries such as the Soviet Union where all the L.W.R. are laid on wood

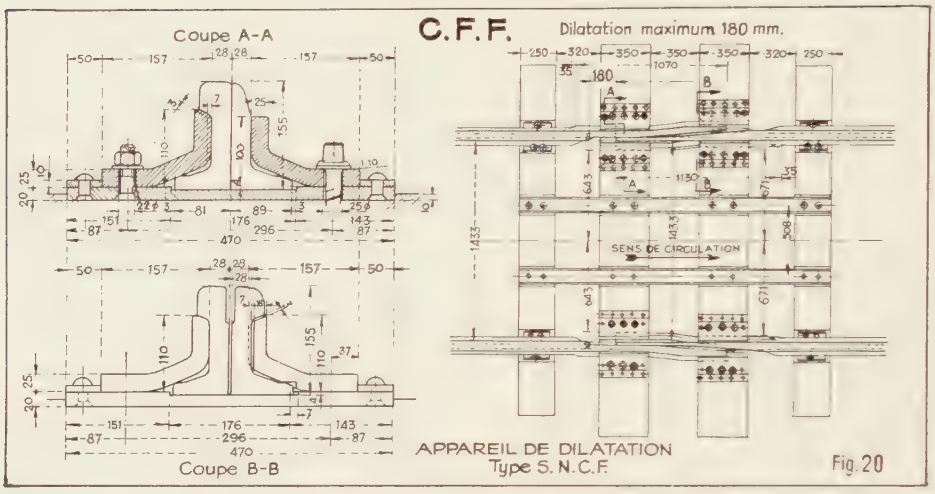


Fig. 20. — *C.F.F. :* S.N.C.F. type expansion device.

N. B. — Dilatation maximum 180 mm = maximum expansion 180 mm. — Sens de circulation = direction of traffic.

sleepers, it is intended to try them with reinforced concrete sleepers.

The Luxemburg and Polish Rys. have found that L.W.R. laid on wood sleepers behave better than those laid on concrete. In spite of this, the Polish Administration also lays L.W.R. on concrete sleepers.

In Luxemburg, the 400 m long rail on wood sleepers shows less movement than the 925 m rail on concrete sleepers, a phenomenon which is perhaps explained by

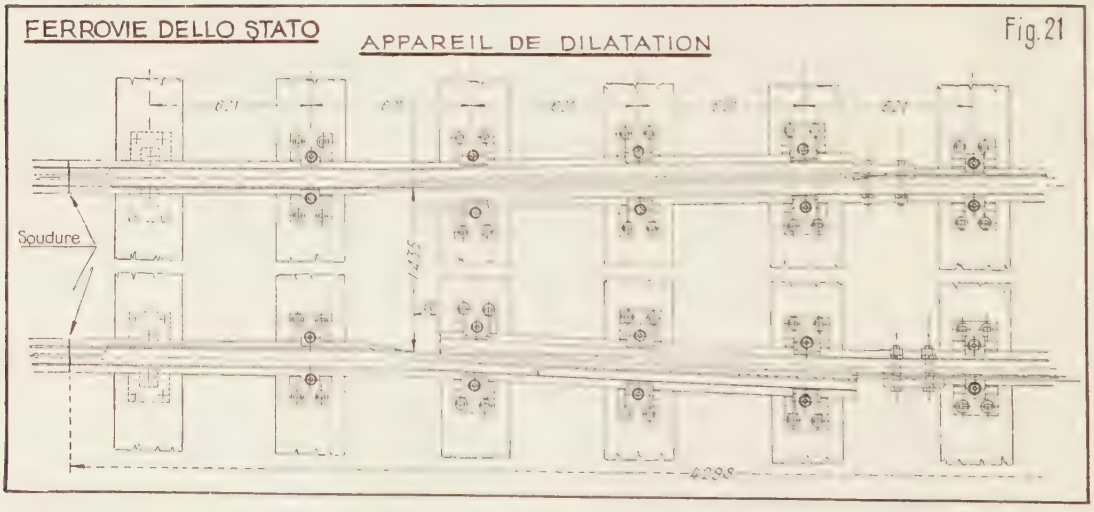


Fig. 21. — *Italian State Rys. :* Expansion device.

the fact that the first rail is laid on 1 669 sleepers per kilometre and the second on only 1 425.

As Table I shows, several Railways have laid their L.W.R. on wood sleepers and the results obtained are satisfactory provided an efficient type of fastening of the rail to the sleepers is used.

The D.B. considers that the « K « (GEO) fastening with wood sleepers (fig. 6) will give satisfaction over a period of 20 to 25 years. After this, the degree of indeformability of the framework of the track appears to be no longer sufficient to allow L.W.R. to be laid.

The French Rys. — S.N.C.F. — and Belgian — S.N.C.B. — lay their L.W.R. on both concrete and wood sleepers. The former use for fastening, RN clips with concrete sleepers (fig. 1 and 2) and RN clamps with or without steel bearing plates with wood sleepers (fig. 3 and 4); the latter RN clips with concrete sleepers and the GEO fastening (fig. 8) with wood sleepers.

The Swiss C.F.F. consider that all three types of sleepers are suitable for jointless track, and the Italian Rys. only lay their L.W.R. on wood sleepers.

The D.B. which, when it began to lay L.W.R. on concrete sleepers, used clips with coachscrews and coachscrew bolts to fasten the rails to the sleepers, now uses the « K » type fastening.

The Danish, Spanish, Dutch and Tunisian Rys. have only laid their L.W.R. on concrete sleepers; the second on account of the fact that the only type of fastening they use with wood sleepers are coachscrews and with these the union of the rail to the sleepers is not sufficiently rigid for making up jointless track.

Six per cent of the L.W.R. of the D.B. have been laid on steel sleepers and about 3 % of those of the Austrian Rys. They both consider that owing to its particularly great resistance to displacement, laying on steel sleepers is very suitable for continuously welded rails. Although its weight is low, this is of no importance as regards buckling upwards since the critical degree of movement, as will be seen from figure 22, is still 9.8 cm.

Ninety-nine per cent of the L.W.R. of the Dakar-Niger Ry. are laid on steel sleepers, and so are all the jointless sections of the Cameroons and Matadi-Leo Rys. In view of the importance of the stresses due to the tightness of the fastenings on metal sleepers, the Algerian Rys. prefer to lay their L.W.R. on this type of sleeper.

Although the S.N.C.V. generally use wood sleepers, laying sections on modern types of road surfaces have led them to adopt he system of laying rails on steel sleepers embedded in a concrete bearing plate.

4.1.2. — *Do you use the same sleeper spacing — number of sleepers per km — with L.W.R. and standard length rails (15 to 36 m)?*

All the Administrations consulted use the same number of sleepers with their L.W.R. as with standard rails, with the sole difference that the spacing between the sleepers is uniform, there being no double sleepers at joints.

On the fishplated lines of the D.B. the normal distance of 63 cm may be increased to 65 cm with suitable conditions of subsoil and track, but this tolerance is not allowed in the case of L.W.R.

The Algerian Rys. increase their sleepering by up to 1 700 sleepers per km on lines with heavy traffic or those on which the speed exceeds 110 km/h.

On the trial rails of the U.S.S.R. with automatic variation of the length according to the temperature, the number of sleepers per km is 1 840, and on lines where the rails are embedded in the sleepers, there are 2 200 per km.

4.1.3. — *Have you found any considerable differences in the behaviour of L.W.R. laid on wood, metal or concrete sleepers?*

It can be stated that in general no Administration has noticed any appreciable differences in the behaviour of L.W.R. laid on wood, concrete or steel sleepers.

4.1.4. — *As regards the resistance of the track to transverse displacement, are not metal or concrete sleepers better than wood sleepers?*

Resistance to lateral displacement is of prime importance for the stability of the track, and from this point of view, the wood sleeper is the least suitable.

The D.B. estimates at 15 % the reduced resistance to lateral displacement of wood sleepers compared with concrete sleepers when measured immediately after laying or after tamping carried out during overhauls. This resistance however increases as time goes on owing to the penetration of the sharp edges of the pebbles of the ballast into the wood (fig. 23) so that after three or four years it slightly exceeds that of lines laid on monolithic concrete sleepers. For the same reason, the resistance to shifting of the track is about 5 to 10 % higher when the sleepers are made of softwood instead of hardwood.

The resistance to lateral displacement of track laid on metal sleepers according to the D.B. is 15 % greater than that of track laid on concrete sleepers, whilst at the end of two years, on account of the consolidation of the ballast, the above percentage is increased to 30 %.

The S.N.C.F. has carried out numerous tests of the lateral resistance of the track (1), measuring this resistance under rolling loads in order to determine its aptitude to avoiding undergoing any deformation in the layout under the effect of dynamic guiding actions. In addition, the resistance to displacement of the ballast on track without load has been measured. The results bring out very clearly the fact that steel sleepers on account of their shape, and concrete sleepers on account of their weight, give greater resistance than wood sleepers.

(1) R. SONNEVILLE and A. BENTOT : Elasticity and lateral strength of the permanent way. I.R.C.A. Bulletin, March 1955, p. 184.

R. SONNEVILLE and A. BENTOT : Lateral strength of permanent way when free from load. I.R.C.A. Bulletin, June 1956, p. 481.

In view of the great influence of the ballast of the sleeper bed on lateral resistance, the D.B. consolidates it mechanically by means of the machine shown in figure 31. By ramming the ballast of the bed the lateral resistance is increased by 5 to 10 % and with mechanical compression by means of a vibrator by 40 to 50 %.

From the point of view of the resistance of the ballast to lateral displacement of the track, the mixed concrete sleepers embedded in the ballast to the level of their upper surface — as is done on the R.E.N.F.E. for other reasons with the RS sleepers — give an increased resistance, as this includes not only the thrust of the ballast of the bed but also that of the ballast between the rails.

4.2.1. — *How do you fasten the L.W.R. to the sleepers? Please join drawings.*

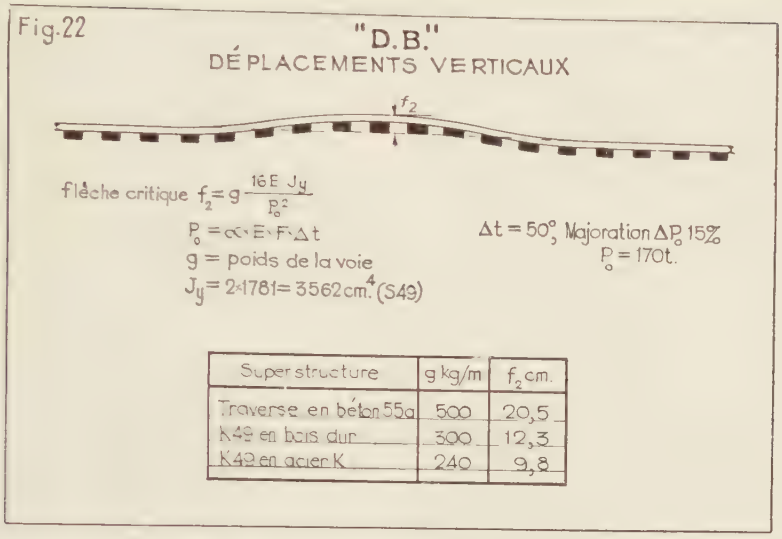
In general the same types of fastenings are used with L.W.R. as with standard lengths of rails, from 12 to 36 or 48 m long.

Thus the D.B. and Ö.B.B. use the K-GEO type fastening both with wood sleepers (fig. 6 and fig. 24) and steel sleepers (fig. 7 and fig. 25) or concrete sleepers (fig. 5 and fig. 26). On the secondary lines, the D.B. has used the Prussian type 15c/8d (fig. 27) and the Ö.B.B. simpler types of fastenings, such as that shown in figure 28. The D.B. types of track with self-tightening fastenings without bearing plates have only been used with L.W.R. experimentally.

The D.B. is endeavouring to discover by means of laboratory tests the most suitable type of fastening for use with L.W.R.

On the S.N.C.B. the fastening used for L.W.R. laid on wood sleepers is also the K type but slightly modified (fig. 8) without a plate between the foot of the rail and the bearing plate.

In the Soviet Union, the fastening used with wood sleepers for L.W.R., without possibility of longitudinal displacement between the rails and the sleepers, is similar to the « K » type used in Germany. In the case of L.W.R. whose length vary



Superstructure	g kg/m	f_2 cm.
Traverse en béton 55a	500	20,5
K49 en bois dur	300	12,3
K49 en acier K	240	9,8

Fig. 22. — *D.B.* : Vertical displacement.

N. B. — Superstructure = superstructure. — Traverses en béton 55 a = 55 a concrete sleepers. — K 49 en bois dur = K 49 hardwood sleeper. — K 49 en acier K = K 49 K steel.

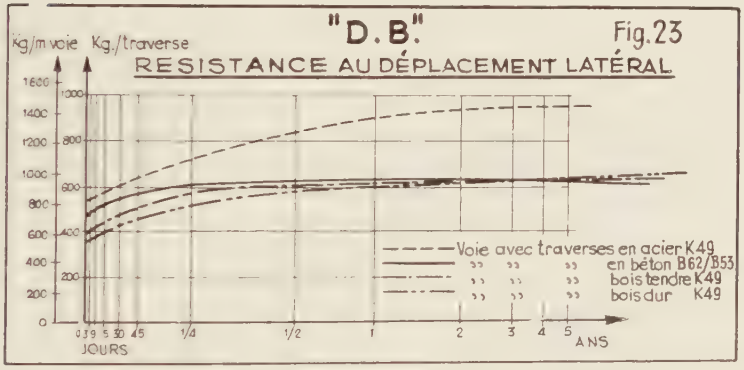


Fig. 23. — *D.B.* : Resistance to lateral displacement.

N. B. — Kg/m voie = kg/m track. — Kg/traverse = kg/sleeper. — Jours = days. — Ans = years. — Voie avec traverses en acier = track with steel sleepers. — En béton = concrete. — En bois tendre = softwood. — En bois dur = hardwood.

automatically with the temperature, the type of fastening includes bearing plates with curved edges, and with these rails use is made of special rectifying equipment placed in the middle of the latter (fig. 29). This equipment (fig. 30) consists of cylindrical springs, fixed at one end to rails anchored in the ground, and at the other to parts fixed to the foot of the rails. The compression load of a spring is 2 000 kg. With a 1 000 m long rail, 15 such rectification equipments are used, spaced out over

the central portion of the rail. It has been found that the longitudinal displacement when a train is passing may be as much as 15 to 20 mm.

The Swiss Rys. (fig. 32) have used various types of fastenings on each of the three kinds of sleepers. On wood sleepers : RN direct fastening with their wood sleepers, or half direct and half indirect (fig. 33); the Czechoslovakian State Rys. the fastening shown in figure 34; the Matadi-Leo Ry. the GEO fastening on metal sleepers.

The S.N.C.F. uses the doubly elastic fastening which it has perfected; it uses this

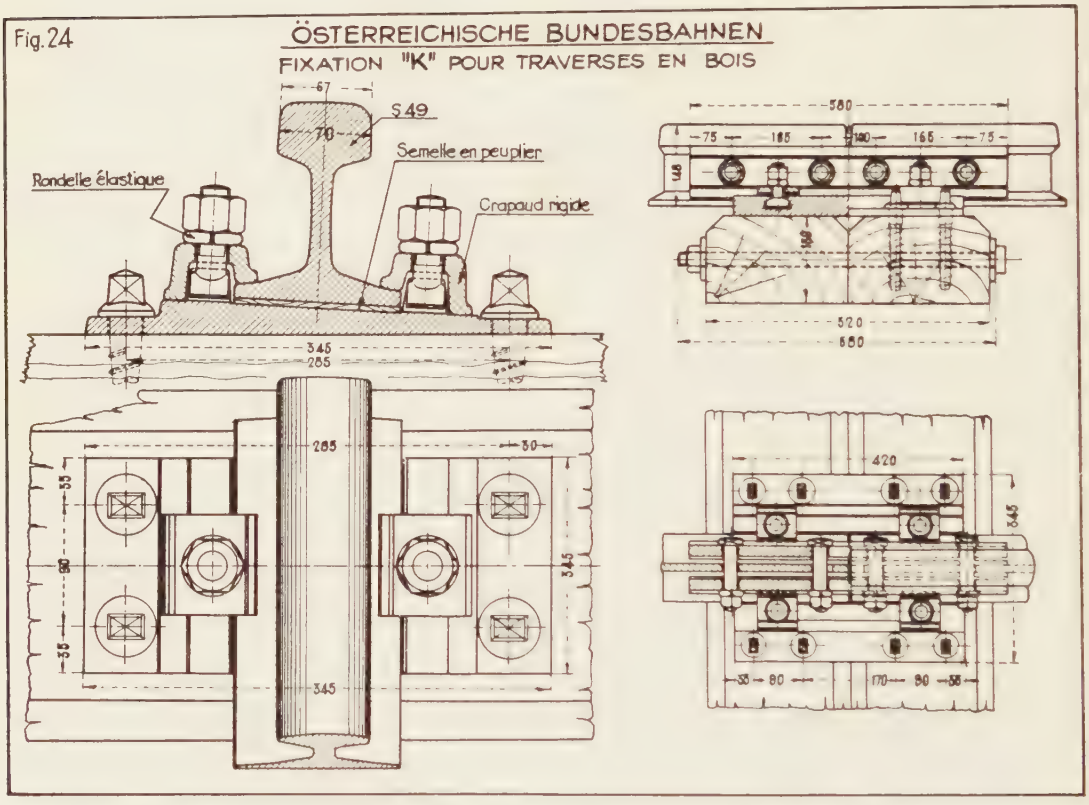


Fig. 24. — *Austrian Federal Rys.* : « K » type fastening for wood sleepers.

N. B. — Rondelle élastique = elastic washer. — Semelle en peuplier = poplar plate. — Crapaud rigide = rigid clip.

bearing plates and spikes or « Ougrée » bearing plates and cotters; on steel sleepers : rigid clips with double elastic washers and rubber pads or RN spikes; on concrete sleepers : RN spikes and rubber bearing plates, GEO fastenings or « Ougrée » bearing plates and cotters.

The Italian Rys. use the GEO type infastening both on concrete sleepers with clips and bearing plates (fig. 1 and 2) and on wood sleepers : spikes with or without bearing plates (fig. 3 and 4). It also uses this type with standard length rails as it acts as an anticreep device and in addition protects the fastenings against the effects of vibrations.

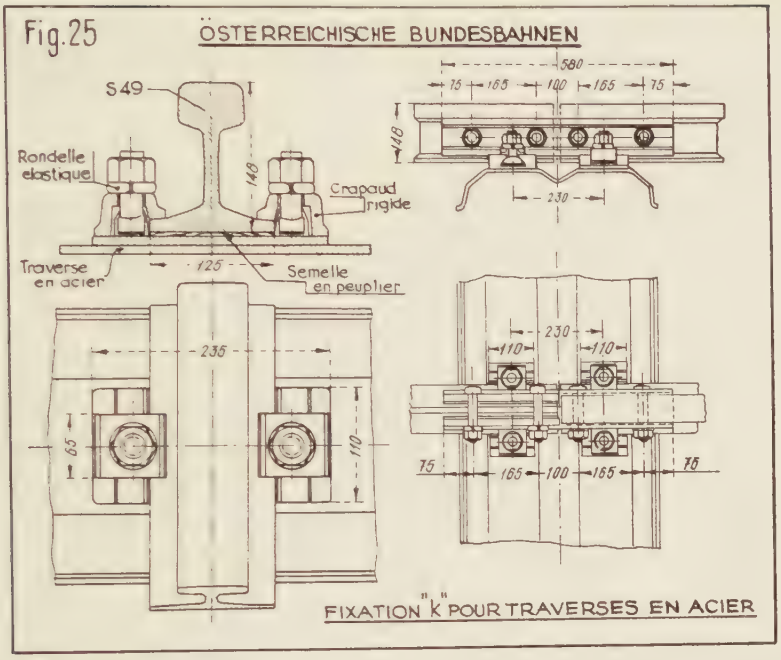


Fig. 25. — *Austrian Federal Rys.* : « K » type fastening for steel sleepers.

N. B. — Rondelle élastique = elastic washer. — Crapaud rigide = rigid clip. — Traverse en acier = steel sleeper. — Semelle en peuplier = poplar plate.

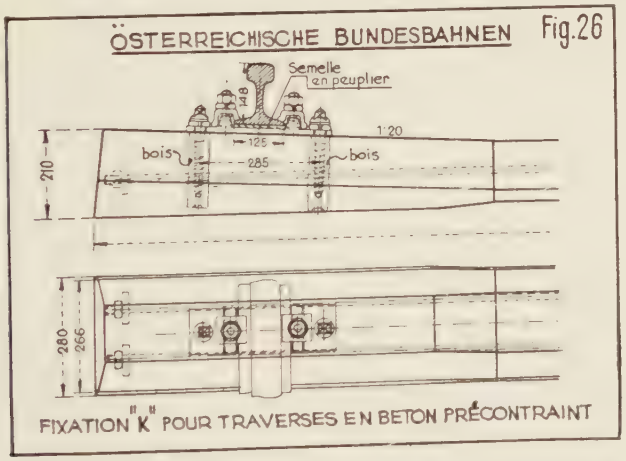


Fig. 26. — *Austrian Federal Rys.* : « K » type fastening for prestressed concrete sleepers.

N. B. — Semelle en peuplier = poplar plate. — Bois = wood.

The S.N.C.B. uses the doubly elastic fastening with RN clips on its concrete sleepers.

The Danish Rys. (fig. 35), the R.E.N.F.E. (fig. 36), the Algerian Rys., the Netherlands Rys. (fig. 37), the Portuguese and Tunisian Rys. also use the elastic type of fastening with satisfactory results. The Danish Rys., in the case of prestressed concrete sleepers use a fastening with clips and bolt-coachscrews (fig. 38).

The Matadi-Leo Ry. states that with the doubly elastic method the « Paulstra » plate

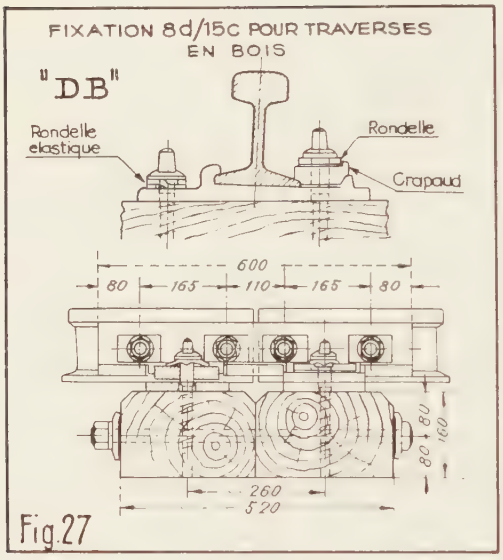


Fig. 27. — *D.B.* : 8 d/15 c fastening for wood sleepers.

N. B. — Rondelel élastique = elastic washer. — Rondelle = washer. — Crapaud = clip.

for insulation does not give sufficient safety as it allows of relative displacements between the clip and the plate. If it is to hold securely the clip must rest directly on the foot of the rail.

The Algerian Rys. made a similar observation. They found that in spite of all the care taken to tighten up the clips, a great many of them had slid on the foot of the rail by the end of the summer.

In order to fix the rail securely to the metal sleeper, the Rhaetian Ry. uses the cotter pins shown in figure 39, and the Algerian and French Overseas Rys. the types of fastenings shown in figures 40 and 41.

4.2.2. — *In general, amongst the methods of fastening used in the case of standard length rails — 15 to 36 m — which methods are equally suitable for use with L.W.R. and which must be avoided?*

The replies from the various Administrations agreed in pointing out that types of fastenings which did not give a secure contact between the rail and sleeper preventing any relative displacement between the two were not suitable for L.W.R.; for example, direct fastenings by means of coachscrews with or without bearing plates.

4.2.3. — *Have you used elastic spikes to fasten your long rails, and if so, with what results?*

The only two Administrations who have fastened their L.W.R. with elastic spikes are : the Ö.B.B. (fig. 42) in the Tauern tunnel — 8.4 km — with « Macbeth » spikes and 64 kg/m rail, and the Italian Rys., who use spikes with bearing plates having edges which grip the foot of the rail. Neither of these two Administrations stated with what results. In the case of the Ö.B.B. as the rail is in a tunnel and not subjected to any considerable temperature variations, it cannot really be considered as a L.W.R.

4.2.4. — *Do you consider that anticreep devices should be used with L.W.R. when the fastenings do not keep the rail firmly anchored to the sleeper :*
a) *with expansion devices;*
b) *without expansion devices?*

As already stated, the D.B. fits anticreep devices (fig. 11) for 50 m at each end of

L.W.R. in order to increase the resistance to longitudinal displacement of the rails in their fastenings, and consider that it is impossible to do without them on lines where the fastenings are getting loose owing to their age. Figures 43 to 46 show the types of anticreep devices used by the D.B.

The Ö.B.B. also fit anticreep devices at the ends of L.W.R. and arrange them as shown in figure 47.

The Italian Rys., although they have not made use of anticreep devices, expressed the opinion that they might be useful where the fastenings are not strong enough to prevent the rails sliding on the sleepers.

The Luxemburg, Swiss and Czechoslovakian Rys. think the same when there are no expansion devices, or when there is excessive displacement of the rails owing to the inadequacy of the fastenings.

The S.N.C.B. holds the contrary opinion, as they state that when there is no expansion device allowing of considerable movement, anticreep devices of any kind are useless.

The other Administrations do not use anticreep devices with their L.W.R.

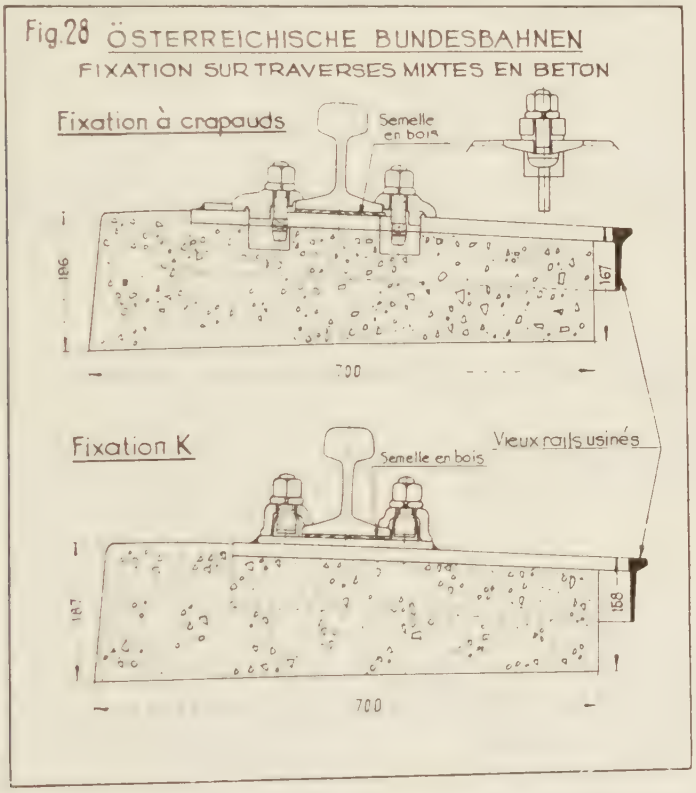


Fig. 28. — *Austrian Federal Rys.* : Fastenings for mixed concrete sleepers.

N. B. — Fixation à crapauds = fastening with clips. — Semelle en bois = wood plate. — Fixation K = K fastening. — Vieux rails usinés = old machined rails.

4.3. — *To increase the transverse resistance of the track — especially on curves — have you considered it advisable to widen the foundation of the permanent way on the outside of the track? Up to what limits can such a widening be considered effective? Please join drawings of ballast section, normal and special for L.W.R. in straight track and on curves.*

Figure 48 shows the ballast profiles adopted by the D.B. as a result of recent trials. The width of the bench in the case of track on concrete sleepers is 0.35 m on both straight sections and curves, and this width is retained when L.W.R. are used with

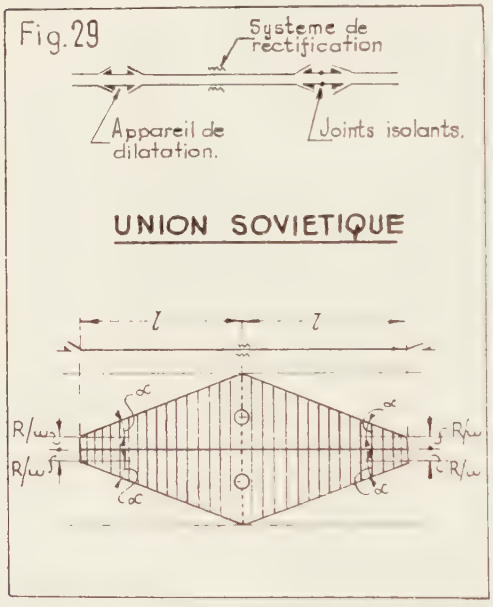


Fig. 29. — *Soviet Union* : Rectification system.
N. B. — Appareil de dilatation = expansion device. — Joints isolants = isolating joints.

wood or steel sleepers. In lines with wood sleepers, the bench is strengthened by ramming, and if this is not used, the ballast of the bench is mechanically compressed. The D.B. does not propose to make any distinction between lines with standard length rails and L.W.R., neither on straight sections nor on curves. When, exceptionally, L.W.R. are laid on curves of less than 500 m radius, special steps will be taken such as fitting clips with anchoring feet and increasing the temperature at which the final welds are made.

It is seen from the trials carried out by the D.B. (fig. 49) that when the bench is widened from 0.35 to 1.0 m the increase in its resistance to shifting is practically linear.

The Austrian Rys. (fig. 50 and 51) retain for the L.W.R. sections the same profile of ballast as with standard rails. But as the concrete sleepers are shorter than the wood sleepers, this amounts to reinforcing the bench. Like the German Rys. in the case of wood or steel sleepers, they increase the ballast at the edge of the bench by about 10 cm in thickness.

Neither the S.N.C.B. (fig. 52) nor the S.N.C.F. (fig. 53 and 55) modify their usual ballast profile for L.W.R.; the former slightly increases the bench of ballast, and the second takes special care to see there are no reductions in the width of the bench.

The S.N.C.B. has carried out tests of the resistance of the bench as a function of its width, taken from the axis of the rail to the upper edge of the inclined plane. The maximum load under which displacement continues without variation in the stress is summed up in the following table :

Width of bench in meters	0.85	1.00	1.25
Maximum load in kg	389	453	467

These trials agree with those carried out on the S.N.C.F. by Messrs. SONNERVILLE and BENTOT, which show that increasing the width of the bench beyond 1 m gives no useful results.

The Danish Rys. (fig. 56), Spanish (fig. 57), Cameroons (fig. 58), French Overseas (fig. 59), Italian (fig. 60) and Swiss

(fig. 61) do not modify their standard type of profile for L.W.R.

The Netherlands and Polish Rys. consider that the bench should be widened in curves. The latter also think there should be up to 40 cm at the head of the sleepers.

The increased ballast profile of the Soviet Union (fig. 62) corresponds to those lines on which the expansion is adjusted periodically in spring and autumn; in the case of L.W.R. with automatic expansion according to the temperature, the normal profile is used.

The Matadi-Leo Ry. considers that widening the bench is effective up to 50 or 60 cm.

To increase transversal resistance in curves and for safety reasons, the S.N.C.V. in Belgium use twin rails when the radii are small.

4.4. — *When laying track with L.W.R. which one of the following methods do you consider best from the point of view of transport to the site :*

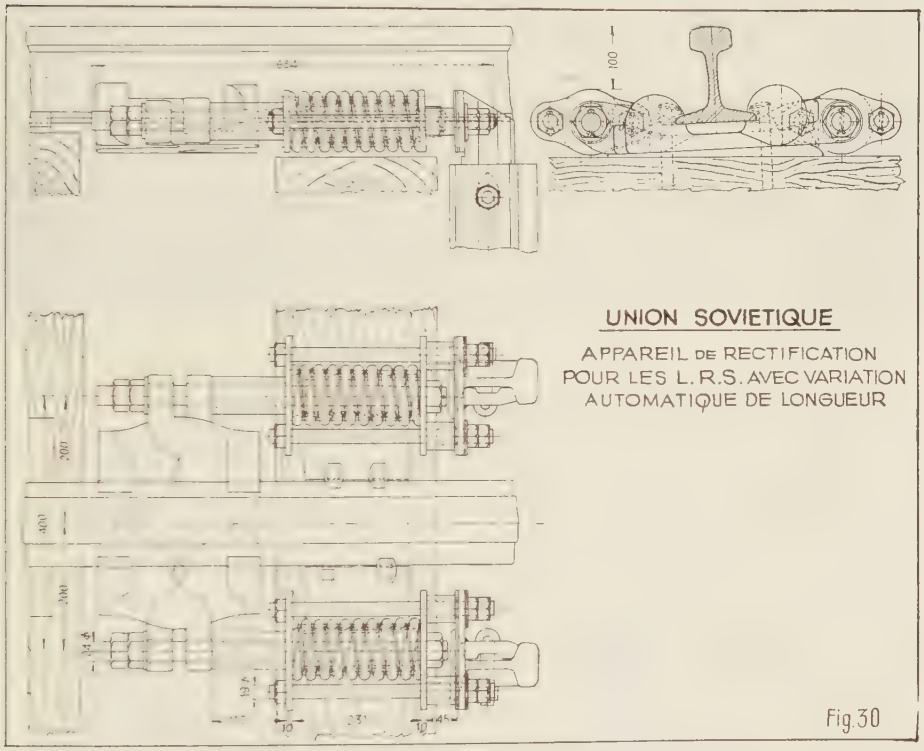


Fig. 30. — *Soviet Union :* Rectification equipment for L.W.R. with automatic length adjustment.

a) *long rails welded in the shops up to lengths of 100 m or more ?*
b) *15 to 36 m long rails ?*
c) *15 to 36 m long sections assembled complete beforehand ?*

Is your choice of method a), b) *or* c) *above based on the speed and*

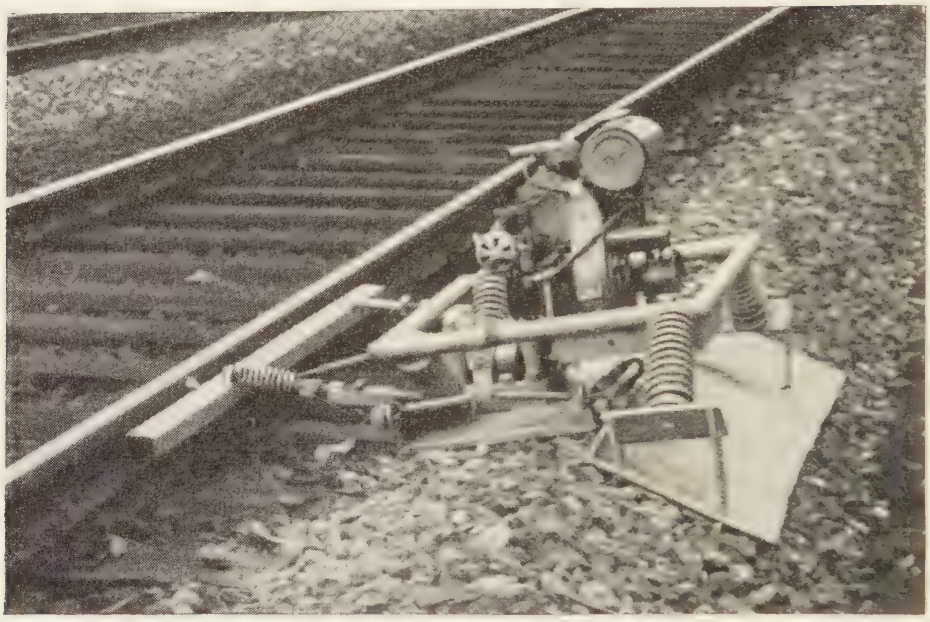


Fig. 31. — *D.B.* : Machine for consolidating the ballast. (Dr Bingmann type).

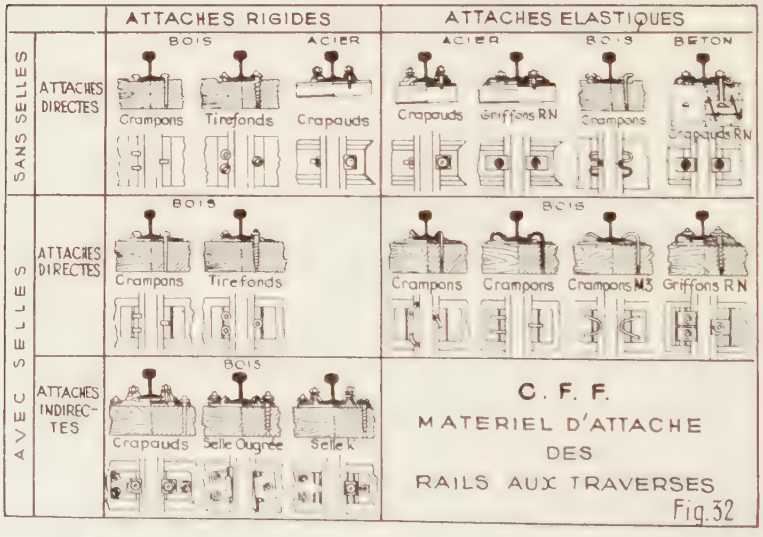


Fig. 32. — *C.F.F.* : Material used in fastening rails to sleepers.

N. B. — Attaches rigides = rigid fastenings. — Attaches élastiques = elastic fastenings. — Sans selles = without bearing plates. — Attaches directes = direct fastenings. — Bois = wood. — Acier = steel. — Béton = concrete. — Crampons = spikes. — Tirefonds = coachscrews. — Crapauds = clips. — Griffon RN = RN dogs. — Avec selles = with bearing plates. — Attaches indirectes = indirect fastenings.

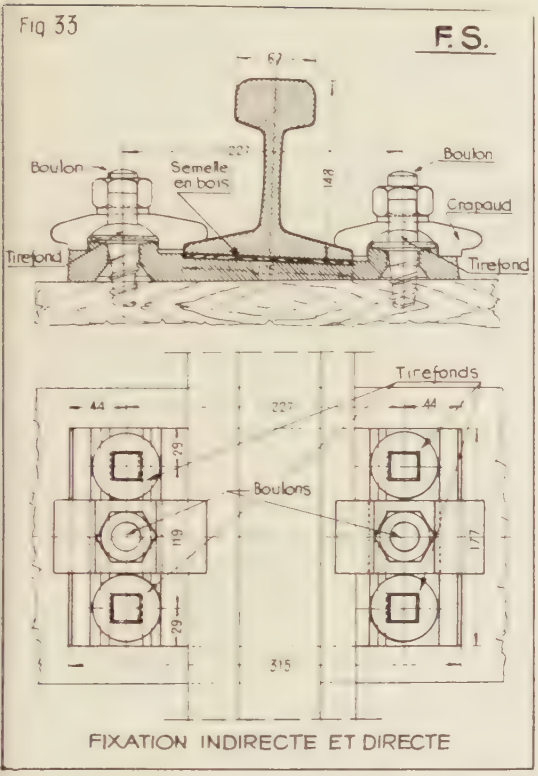


Fig. 33. — *F.S.* : Direct and indirect fastenings.

N. B. — Boulon = screw-bolt. — Semelle en bois = wood plate. — Crapaud = clip. — Tirefond = coachscrew.

facility of laying in this case, or is it based solely on economic considerations?

If you know the cost of the three methods of laying given above — or of equivalent methods — please give us details of the results obtained.

The method consisting of flash butt welding the rails into long lengths in the shops as a beginning is preferred by the German, Belgian, Danish, French, Polish, Russian, Swiss and Czechoslovakian Rys. The reasons for such a preference are as follows :

a) Flash butt welding is the most economical method and gives the highest mechanical values;

b) The cost of the operation which consists in drawing the L.W.R. down the train at the end of rakes fitted out for the purpose of carrying them is lower than the cost of unloading 12 to 48 m long rails sideways;

c) Long rails constitute an ideal track for the track laying machinery;

d) This method makes it possible to press ahead with renewals at great speed.

On the S.N.C.F., the lengths welded in the shops have increased progressively up to about 300 m and mechanical methods have been sought after to reduce the labour required for handling on the site.

On the S.N.C.B., lengths of up to 243 m are prepared in the shops, and on the C.F.F., lengths of 216 m are flash butt welded since 1957.

The Polish Rys. take rails of 240 m welded in the shops to the site.

In the Soviet Union and in Czechoslovakia, lengths of 100 m are prepared in the shops, and the former is now perfecting a method of transport for bringing rails up to 800 m to the working site.

In the case of new lines, L.W.R. laid to date on the Dakar-Niger Ry. have been made up from standard length rails. In the future 700 km of tracks are to be renewed and in this case it is proposed to prepare 140 m long rails in the shops and take these to the site to be made into L.W.R. « in situ ».

As so far the L.W.R. of the Algerian Rys. have been made up from the existing lengths of 36 and 72 m, the problem of prefabricated long rails has not arisen. During renewals, 72 m long rails have been carried on trains of trucks or lorries.

On the Austrian, Spanish and Italian Rys., the usual method of making L.W.R. is to bring up 30 to 48 m rails to the site and then weld them together. When the rails are intended for tunnels, the R.E.N.F.E. makes up by thermit welding

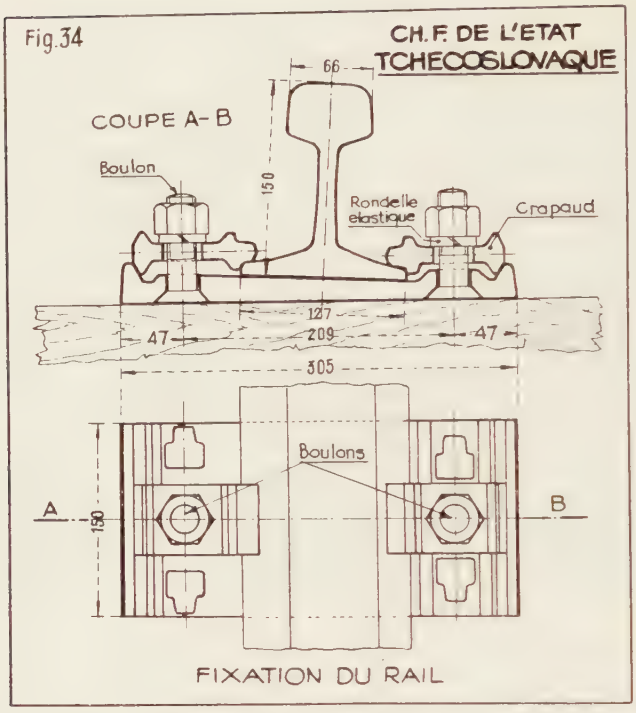


Fig. 34. — *Czechoslovakian State Rys.* — Rail fastenings.

N. B. — Coupe A-B = section A-B. — Boulon = screw-bolt. — Rondelle élastique = elastic washer. — Crapaud = clip. —

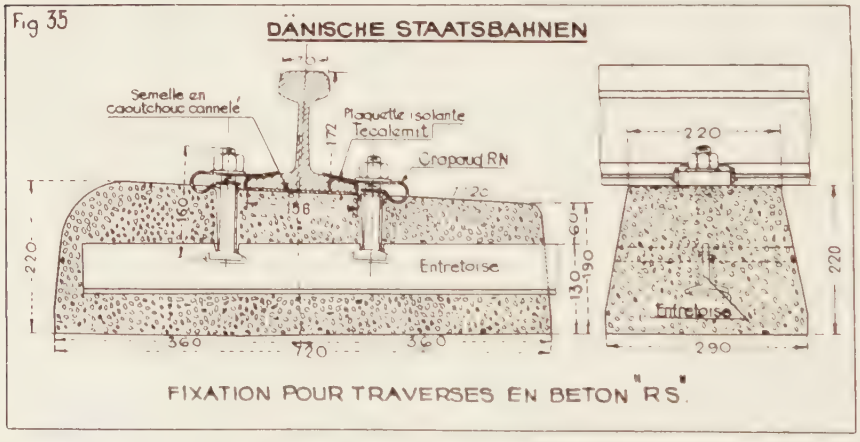


Fig. 35. — *Danish State Rys.* : Fastenings for RS concrete sleepers.

N. B. — Semelle en caoutchouc... = grooved rubber plate. — Plaquette isolante Tecalemit = Tecalemit isolating plate. — Crapaud RN = RN clip. — Entretoise = cross-piece.

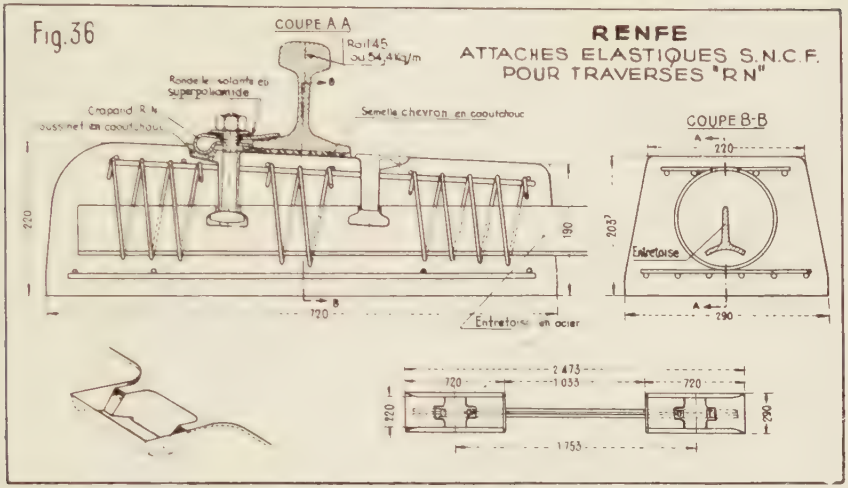


Fig. 36. — *R.E.N.F.E. : S.N.C.F.* elastic fastenings for « *RN* » sleepers.

N. B. — Coupe A-A = section A-A. — Rail 45 ou 54.4 Kk/m = rail 45 or 54.4 kg/m. — Rondelle isolante en superpoliamide = isolating washer of superpoliamide. — Crapaud RN = RN clip. — Coussinet en caoutchouc = rubber pad. — Semelle chevron en caoutchouc = chevron rubber bearing plate. — Entretoise en acier = steel cross piece.

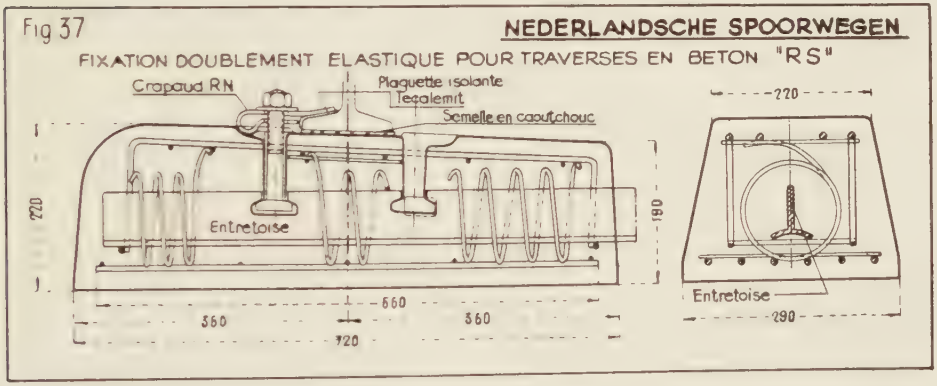


Fig. 37. — *Netherlands Rys. :* Double elastic factening for « RS » concrete sleepers.

N. B. — Crapaud RN = RN clip. — Plaquette isolante Tecalemit = Tecalemit isolating plate. — Semelle en caoutchouc = rubber bearing plate. — Entretoise = cross piece.

close to the place of use 250 m lengths which are then taken to the site on trains of trucks. The Italian Rys. weld 108 m long rails in similar cases.

The S.N.C.V., Matadi-Leo, Rhaetian, Cameroons and Tunisian Rys. do most of their welding on the line.

Welding 15 to 45 m rails into L.W.R. on site is only done on the D.B. in the case of old rails when their condition and that of the sleepers makes this possible.

Laying completed lengths of track more than 15 m long has not given good results on the D.B. as the lengths easily get de-

formed and additional work has to be done to straigthen them.

The S.N.C.F. has made up some of its L.W.R. lengths by laying made up sections of various lengths, but has now gone over to the solution mentioned above of making up long lengths in the shops.

The trial section of the Danish Rys. was laid in 60 m spans made up in a site at a station and then taken to the place where they were to be laid. The 60 m rails had

The criterion for deciding the laying temperature, i.e. that at the time when the centre part of the rail is fastened down and immobilised, is practically the same on all the Railways; the average temperature over the year or slightly higher.

The D.B. lays down that the last welds — the anchoring welds — for no matter what type of sleeper must be made with a rail temperature 5° C. higher than the average over the year, with a tolerance of

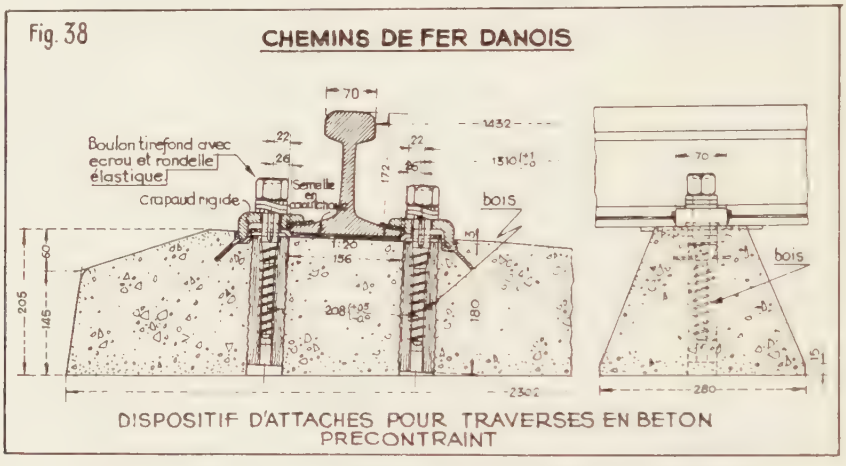


Fig. 38 .— *Danish Rys. :* Fastenings for prestressed concrete sleepers.

N. B. — Boulon tirefond avec... = bolt coachscrew with screw and elastic washer. — Crapaud rigide = rigid clip. — Semelle en caoutchouc = rubber bearing plate. — Bois = wood.

previously been flash butt welded in the shops.

The D.B. was the only Administration to give the cost of methods *a*), *b*) and *c*) of the questionnaire, which are in the ratio of 1 : 1.2 : 1.5 approx.

4.5.1. — *Once the maximum temperature variations in localities where L.W.R. are laid are known, how do you decide the temperature at which such rails are to be laid, i.e. the temperature to be used as a basis for setting up the joints in the expansion devices, or at which the final welds will be carried out if there are no joints left?*

± 3° C. Applying this criterion for the average over the year of + 15° C., the laying temperature must be between + 17 and + 23° C.

The Ö.B.B. apply an identical criterion in the case of their lines on wood or steel sleepers: on the other hand, with concrete sleepers, in theory the temperature should be — 5° C., i.e. + 10° C. which becomes + 7° and + 13° taking into account the tolerance of ± 3° C.

The S.N.C.B. consider the optimum temperature lies between + 15° and + 20° C. If the laying temperature is designated by t_0 the opening between the points of the expansion joints must be fixed by means of the following double formula :

in spring and summer :

$$0.032\ (55° - t_0)^2$$

in autumn :

$$224 - 0.32\ (t_0 + 30°)^2.$$

The above formulae are based on 1 555 sleepers per km and the temperature is taken in the heart of the rail.

On the S.N.C.F. the tightening up temperature is + 25° C. which is the time when all precautions are taken to see that the rail is correctly levelled and straightened and the profile of the ballast is well filled. Once the centre part of the rail has been fastened down, the expansion devices are regulated according to this temperature. When the temperature at which the device is regulated differs from the theoretical one, the neutral opening of the device (90 mm) is increased or reduced by 1.5 mm for each degree above or below + 25°.

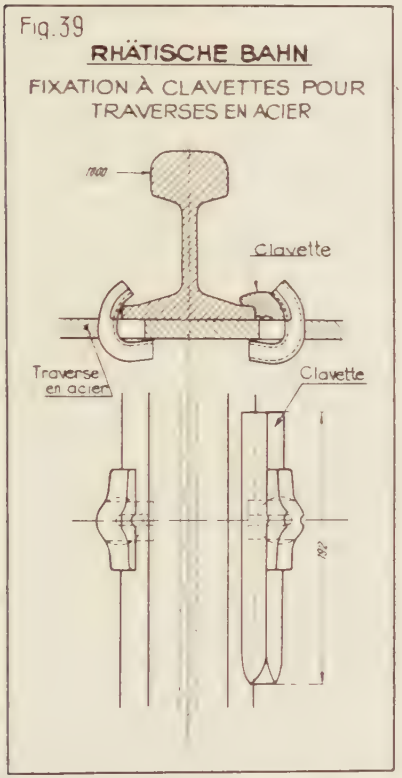


Fig. 39. — *Rhaetian Ry. :* Fastening with cotter pins for steel sleepers.

N. B. — Traverse en acier = steel sleeper. — Clavette = cotter.

If at the time of tightening up, the temperature is outside the limits of + 14° to 36° C., the S.N.C.F. releases the stresses under average temperature by laying the L.W.R. on rollers.

The S.N.C.F. standards have been adopted by the R.E.N.F.E. and Algerian Rys.

The C.F.F. take + 20° C. as the laying temperature with tolerances of ± 7° C., and the Italians + 25° to 30° C.

The Cameroons Rys. do not take any precautions as regards temperature when making up their L.W.R. and the Dakar-Niger Ry. carries out the final welds at temperatures of between + 30° and + 45° C.

The Polish Rys. have fixed the laying temperature at + 15° C. and the Czechoslovakian Rys. at + 10° with tolerances of ± 5°.

4.5.2. — *Do you heat the rails in order to get by artificial means the required temperature for correct laying? If so, how and with what success?*

The D.B. is the only Administration which reheats the rails if in the spring and at the end of the autumn or in winter the temperature stipulated for L.W.R. is not reached. For this purpose use is made of specially designed heating tubes (fig. 63) heated by propane-oxygen. The artificial raising of the temperature to the number of degrees required has given good results. The consumption of fuel for a heating rate of 8 m/min is 30 kg of propane and 8 m³ of oxygen per km of track. The mechanisation of the operation of suppressing internal stresses by means of a vibrator equipment fitted on a truck reduces the labour

requirements to only 10 man days per km of line (1).

The Ö.B.B. are also considering heating rails so that they can lay L.W.R. independently of atmospheric conditions.

4.5.3. — *If the long rails are made up from 15 to 36 m long rails, in what order are the welds made so as to keep the stresses as low as possible ?*

The D.B. and Ö.B.B. make up their L.W.R. by first of all welding the rails continuously into 3 × 120 = 360 m lengths, no matter what may be their individual lengths, temperature and internal stresses. These temporary sections of 360 m which have to be properly ballasted according to the regulations when at the proper temperature, are freed from their internal stresses, after which their fastenings are completely tightened up and the final welds made.

It is very important that the rails are able to move freely whilst the stresses are being liberated, in order that this takes place properly. To get good results, it is a good thing to put the rails on rollers and hammer them energetically with mallets.

The R.E.N.F.E. works in the same way, but the lengths welded at first are 24 × 10 = 240 m.

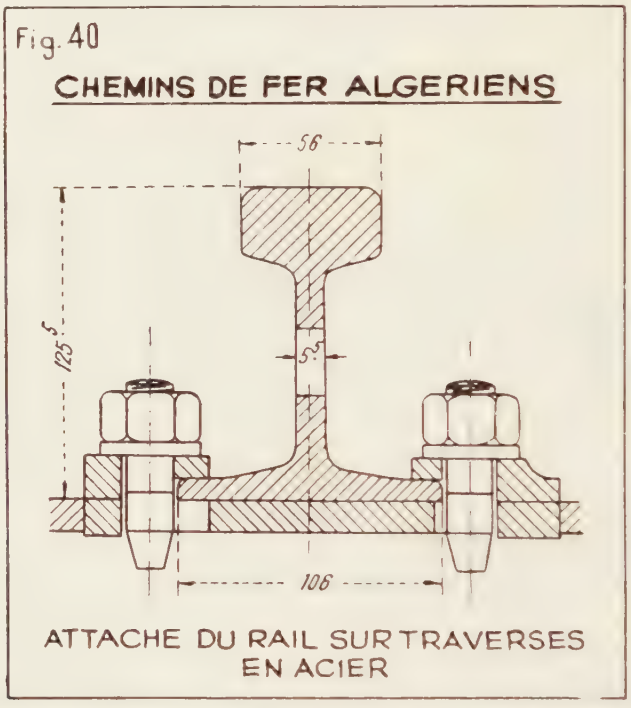


Fig. 40. — *Algerian Rys.* : Fastening of rail on steel sleepers.

(1) M. K. KUHLMANN : « Weitere Erfahrungen mit dem Herstellen durchgebend geschweisster Gleise und Weichen », « Eisenbahningenieur », 1956, Heft 8.

F. BERMANN : « Erfahrungen der DB mit dem durchgehend geschweissten Gleis ». Appendix to above mentioned work by J. WATMANN.

The L.W.R. of the Dakar-Niger Ry. are formed by making up first of all by welding at a fixed site or on the line 120 to 150 m long rails, which are held together by blocks without drilling any holes in the rails. The bolts of the clips have to be tightened up when the temperature of the rails is between 30 and 45° C. and at this moment the joint gaps should be between 10 and 12 mm. These 120 to 150 m long rails are only welded during the hours when the temperature of the rails is between 30° and 45° after a certain number of trains — i.e. 6 ordinary or 15 service trains — have run over the section.

On most Administrations, the order in which the welds are made is the order in which the work proceeds or else from the middle of the rail out towards the ends to join up with the points of the expansion devices.

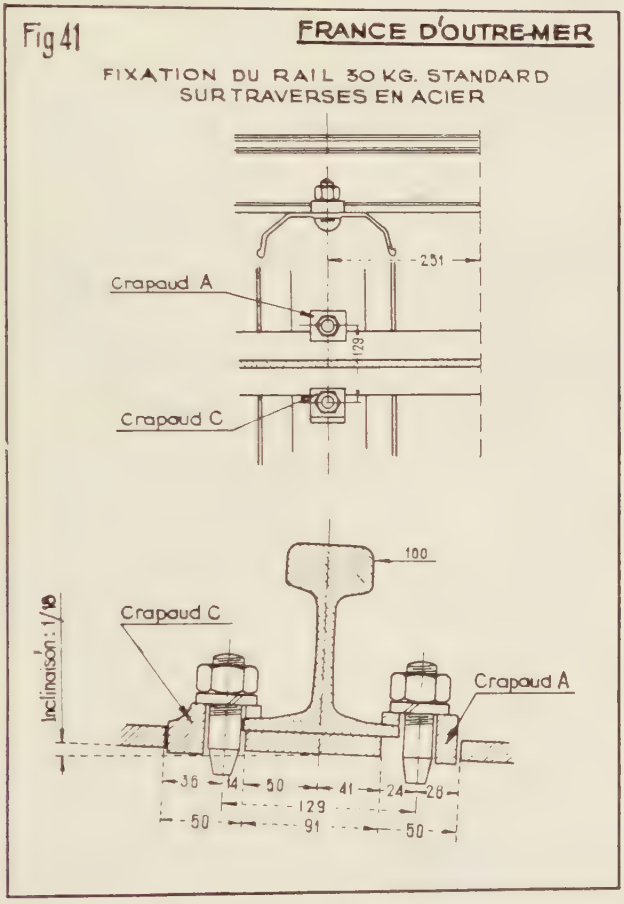


Fig. 41. — *French Overseas Rys.* : Fastening for standard 30 kg rail to steel sleepers.

N. B. — Crapaud = clip. — Inclinaison = inclination.

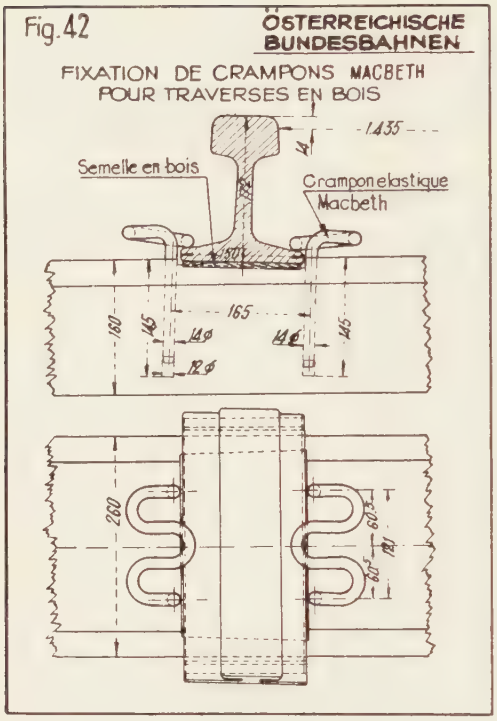


Fig. 42. — *Austrian Federal Rys.* : Fastening with Macbeth rail spikes for wood sleepers.

N. B. — Semelle en bois = wood bearing plate. — Crampon élastique Macbeth = Macbeth elastic spike.

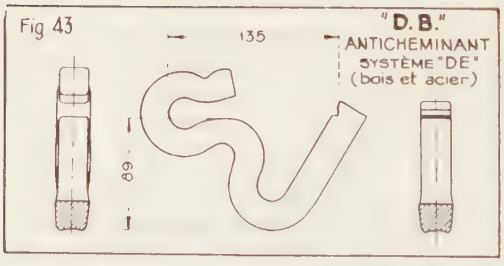


Fig. 43. — *D.B.* : « DE » type anticreep device (wood and steel).

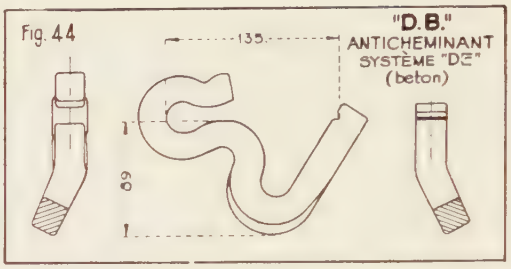


Fig. 44. — *D.B.* : « DE » type anticreep device (concrete).

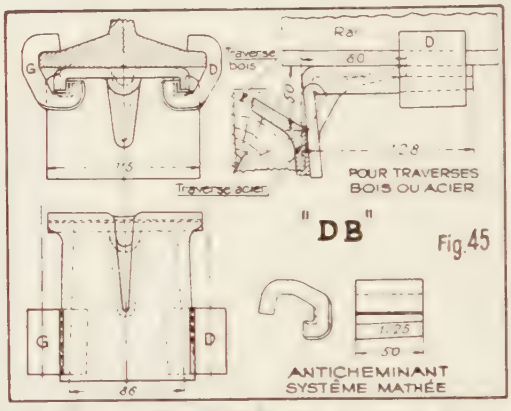


Fig. 45. — *D.B.* . Mathee type anticreep device for wood or steel sleepers.

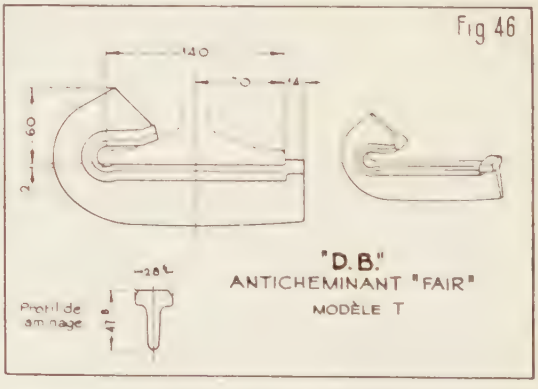


Fig. 46. — *D.B.* : « Fair » type « T » anticreep device.

N. B. — Profil de laminage = section as rolled.

4.6. — *Are the sleepers carrying the L.W.R. laid directly on the normal type of ballast or on an intermediate layer of fine gravel some centimetres thick?*

In which case does the stabilization of the track occur the quickest?

the rails has been given up and replaced by laying direct on ordinary ballast. The consolidation of the latter is obtained either by means of rollers, or vibrators, or merely by the action of the passing trains during the operations of remaking the line. The reason for giving up using bands of gravel

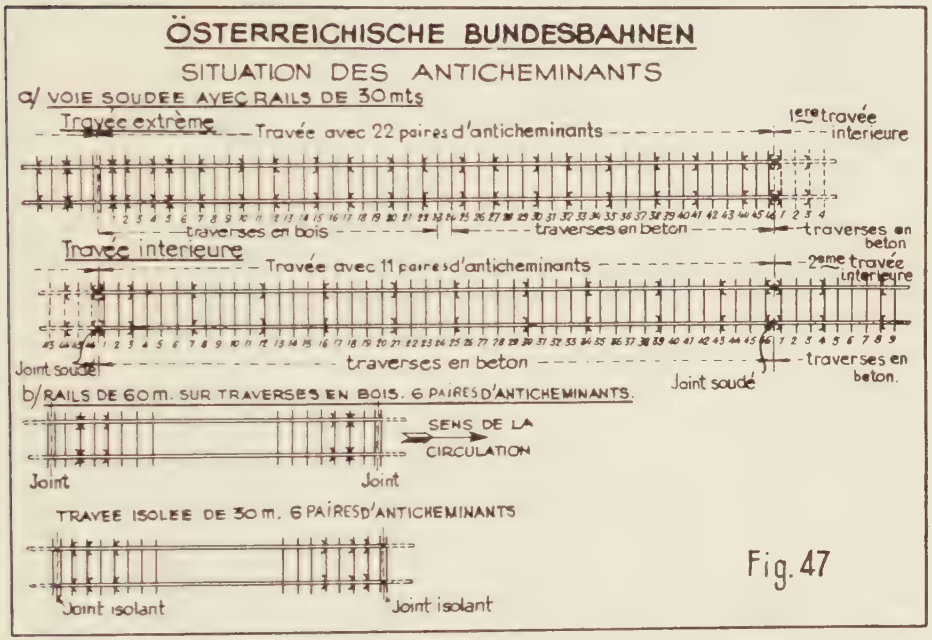


Fig. 47. — *Austrian Federal Rys.* : Position of anticreep devices.

N. B. — Voie soudée avec rails de 30 mts = welded track with 30 m rails. — Travée extrême = outer section. — Travée avec 22 paires d'anticheminants = section with 22 pairs of anticreep devices. — 1re travée intérieure = first inner section. — Traverses en bois = wood sleepers. — Traverses en béton = concrete sleepers. — Travée intérieure = interior section. — Travée avec 11 paires d'anticheminants = section with 11 pairs of anticreep devices. — 2e travée intérieure = second inner section. — Joint soudé = welded joint. — Rails de 60 m sur traverses en bois, 6 paires d'anticheminants = 60 m rails on wood sleepers, 6 pairs of anticreep devices. — Sens de la circulation = direction of traffic. — Joint = joint. — Travée isolée de 30 m, 6 paires d'anticheminants = isolated 30 m section, 6 pairs of anticreep devices. — Joint isolant = isolated joint.

All the Administrations, unanimously, lay the sleepers carrying the L.W.R. on ballast of standard dimensions, since the difference noted by the Tunisian Rys. who laid them on 20/40 ballast instead of 20/50 was practically nil.

The methods used by some railways of laying the sleepers on bands of gravel 0.90 m wide, arranged longitudinally below is that these are the cause of a reduction in resistance to lateral displacement.

On the D.B., when the L.W.R. are laid on wood sleepers, the bench is compressed by mechanical means.

The Ö.B.B. follow two different methods in laying the sleepers on the ballast according to whether the work is done without any trains for long periods or whether it

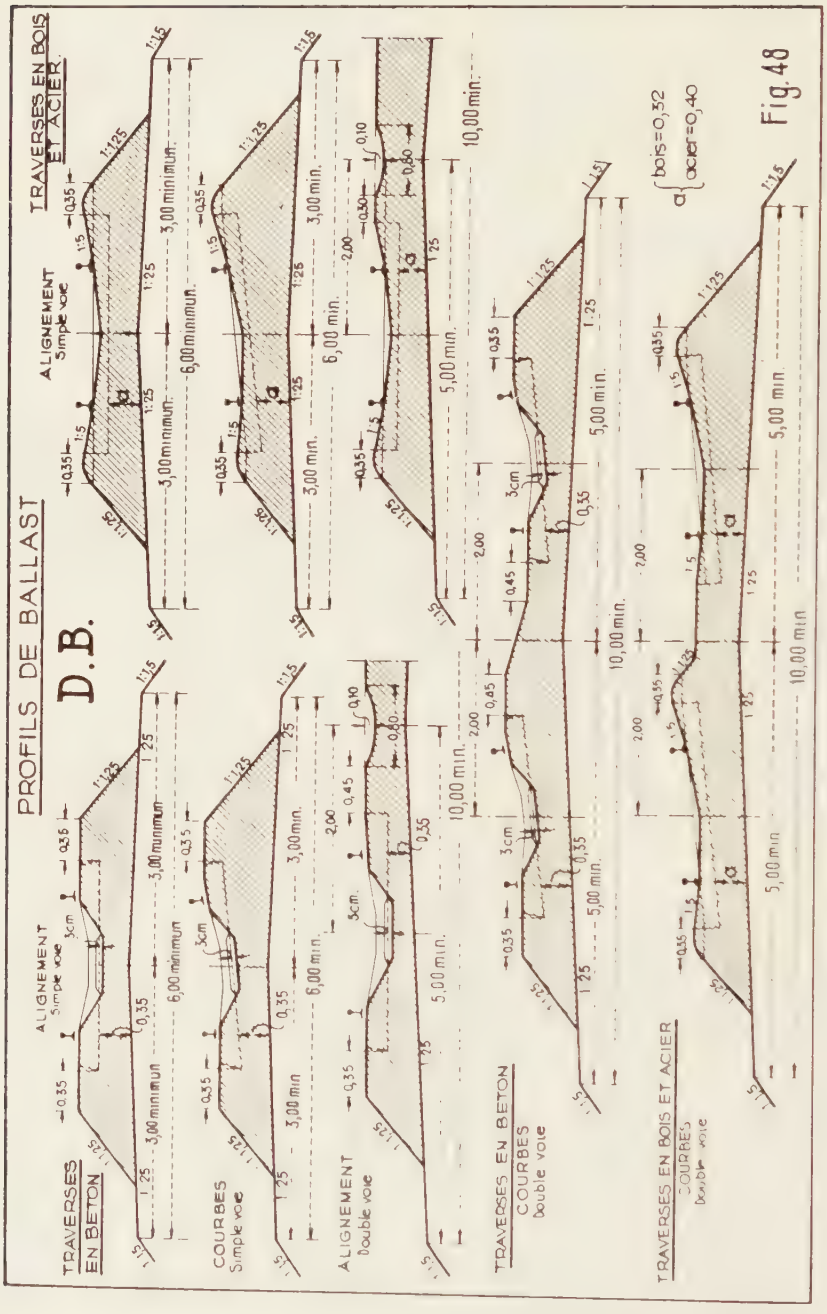


Fig. 48. — *D.B.* : Ballast profiles.

N. B. — Traverses en béton = concrete sleepers. — Alignement, simple voie = straight sections, single track. — Traverses en bois et acier = wood and steel sleepers. — Courbes, simple voie = curves, single track. — Alignement, double voie = straight sections, double track. — Courbes, double voie = curves, double track. — Bois = wood. — Acier = steel.

is carried out without interrupting the services. In the first case, two bands of ballast 35/70 and 0.90 m wide are laid and made sufficiently high to serve as a support for the concrete sleepers without tamping. On the other hand, when the surface of the ballast cannot be raised to its final level — work carried out without interrupting the services or with only short intervals — it is necessary to use tampers.

On the Spanish and Algerian Rys., only the expansion joints are laid on 15/30 gravel.

The Swiss Rys. considered that laying a layer of fine gravel can only be considered as a temporary regulating coat, especially when laying concrete sleepers.

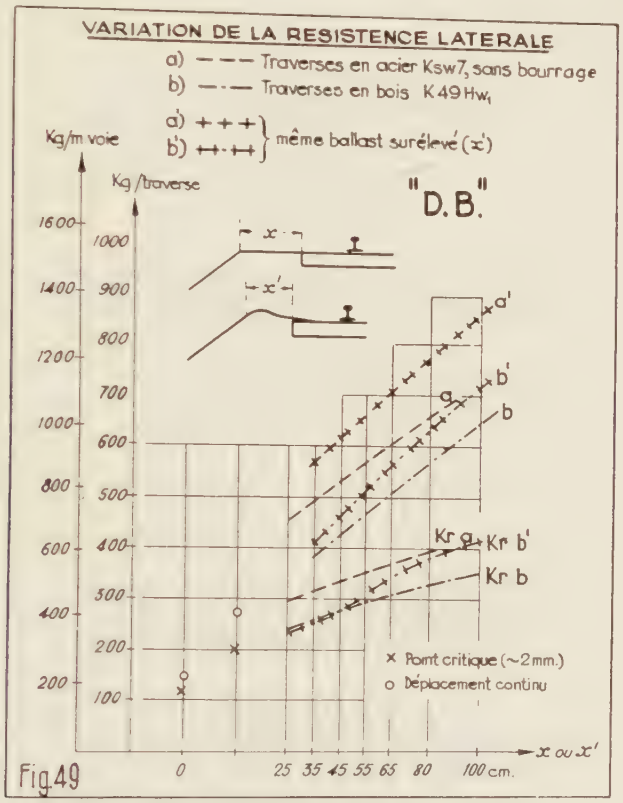


Fig. 49. — Variation in lateral resistance.

N. B. — Traverses en acier Ksw 7, sans bourrage = Ksw 7 steel sleepers without tamping. — Traverses en bois K 49 Hw_1 = K 49 Kw, wood sleepers. — Même ballast surélevé (x') = same ballast increased in height (x'). — Kg/m voie = km/m track. — Kg/traverse = kg/sleeper. — Point critique = critical point. — Déplacement continu = continuous displacement.

4.7. — *Is the present tendency to reduce the amount of ballast used, leaving the spaces between the sleepers almost without ballast, advisable in the case of L.W.R.? Does not this*

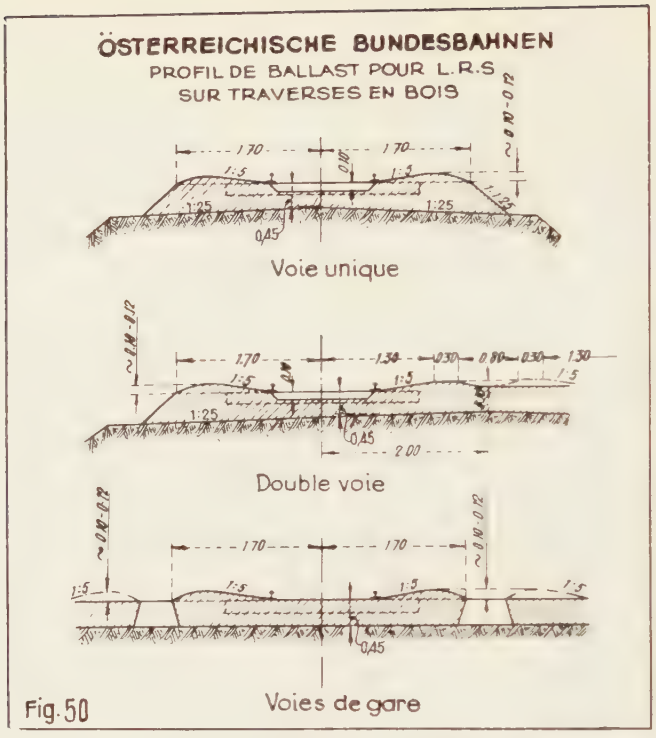


Fig. 50. — *Austrian Federal Rys. :* Profile of ballast for L.W.R. on Wood sleepers.

N. B. — Voie unique = single track. — Double voie = double track. — Voies de gare = tracks in station.

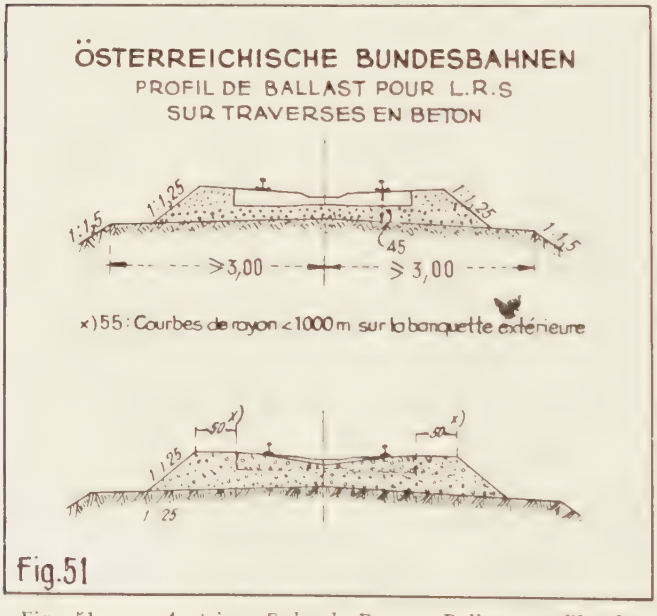


Fig. 51. — *Austrian Federal Rys. :* Ballast profile for L.W.R. on concrete sleepers.

N. B. — x) 55 : Courbes de rayon... = x) 55 : Curves of radius < 1 000 m on the outer bench.

affect the lateral strength of the track?

In order to increase longitudinal resistance to displacement of the track due to changes in temperature and the transverse resistance, it is of value to ballast completely track laid with L.W.R. For this reason, most of the Administrations are of the opinion that the whole bed should be well filled in with ballast.

Even Administrations like the D.B. and Ö.B.B. who laid their concrete sleepers with a centre furrow between the rails, have altered this standard recently and fill in these furrows with ballast once the seating of the sleepers is well stabilised.

Some Railways — the Algerian and French Overseas — used to reduce the quantity of ballast, but they have given up doing this.

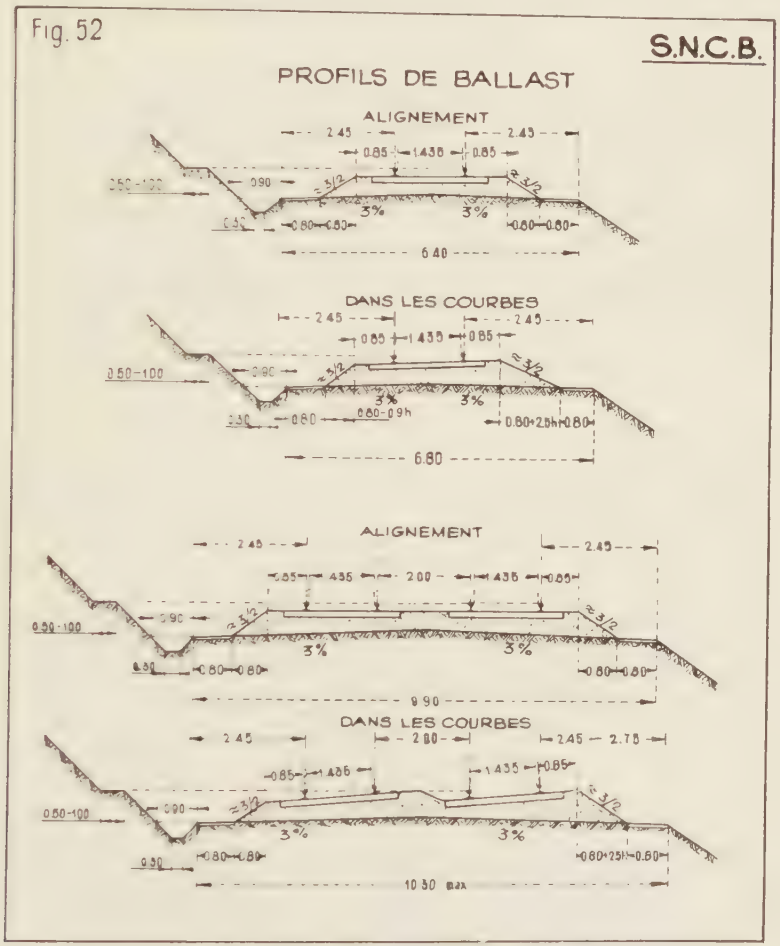


Fig. 52. — *S.N.C.B.* : Ballast profiles.

N. B. — Alignement = straight sections. — Dans les courbes = curves.

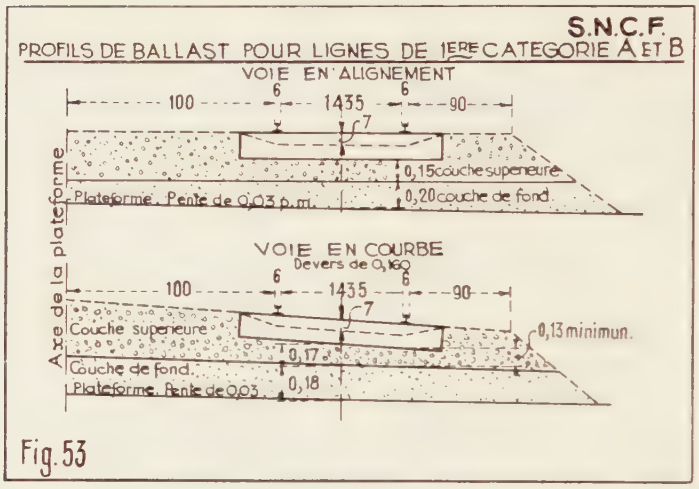


Fig. 53. — *S.N.C.F.* : Ballast profiles for first class lines A and B.

N. B. — Voie en alignement = straight section. — Voie en courbe, devers de 0.160 = curve, 0.160 superelevation.

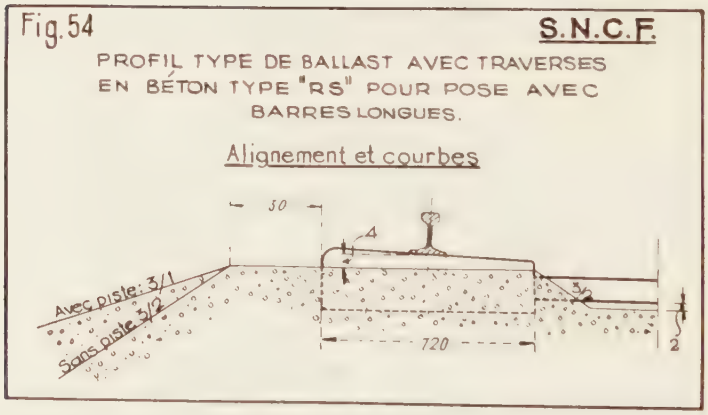


Fig. 54. — *S.N.C.F.* · Typical ballast profile with type « RS » concrete sleepers for use with long rails.

N. B. — Alignement et courbes = straight sections and curves. — Avec piste = with pathway. — Sans piste = without pathway.

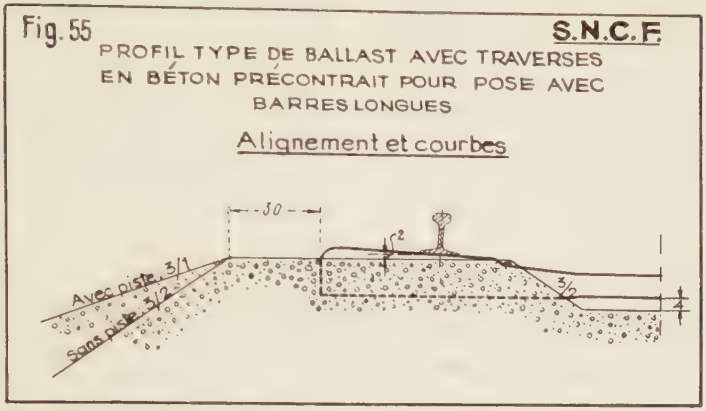


Fig. 55. — *S.N.C.F.* : Typical ballast profile with prestressed concrete sleepers for use with long rails.

N. B. — Alignement et courbes = straight sections and curves. — Avec piste = with pathway. — Sans piste = without pathway.

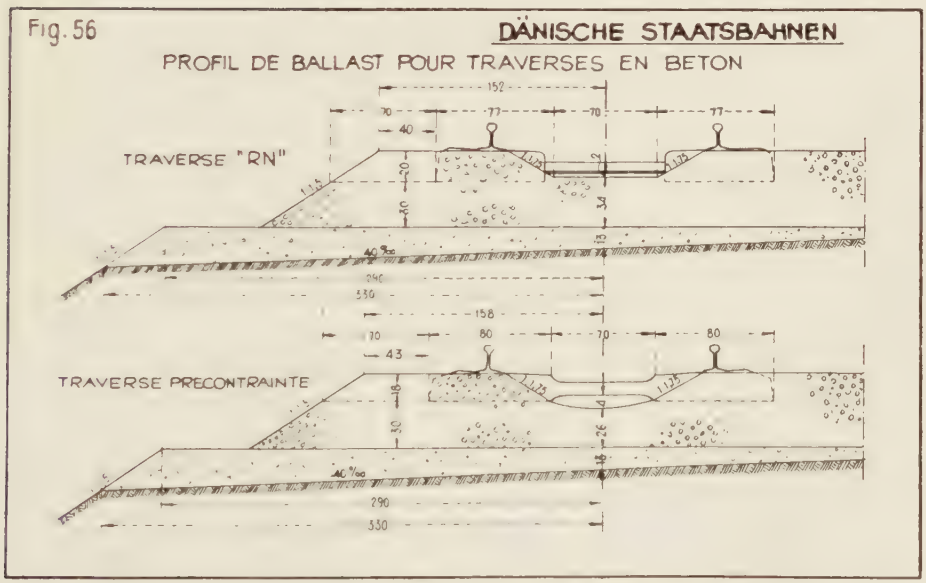


Fig. 56. — *Danish State Rys.* : Ballast profile for concrete sleepers.

N. B. — Traverse « RN » = « RN » sleeper .— Traverse précontrainte = prestressed concrete sleeper.

The R.E.N.F.E. fills the spaces up to the top of the RS sleepers, whilst the Tunisian Rys. only fill up to the level of the cross pieces.

The S.N.C.F. (fig. 1 to 4) in the part between the rails, remove the ballast till it is 7 cm below the level of the sleeper, and the C.F.F. to 5 cm.

for those in force whilst renewal work is being carried out on track with standard rails, once the traffic is allowed to resume.

On the Matadi-Leo Ry., the speed restrictions are due solely to the fact that the trains are running over non-stabilised track. This restriction reduces the speed to 40 km/h.

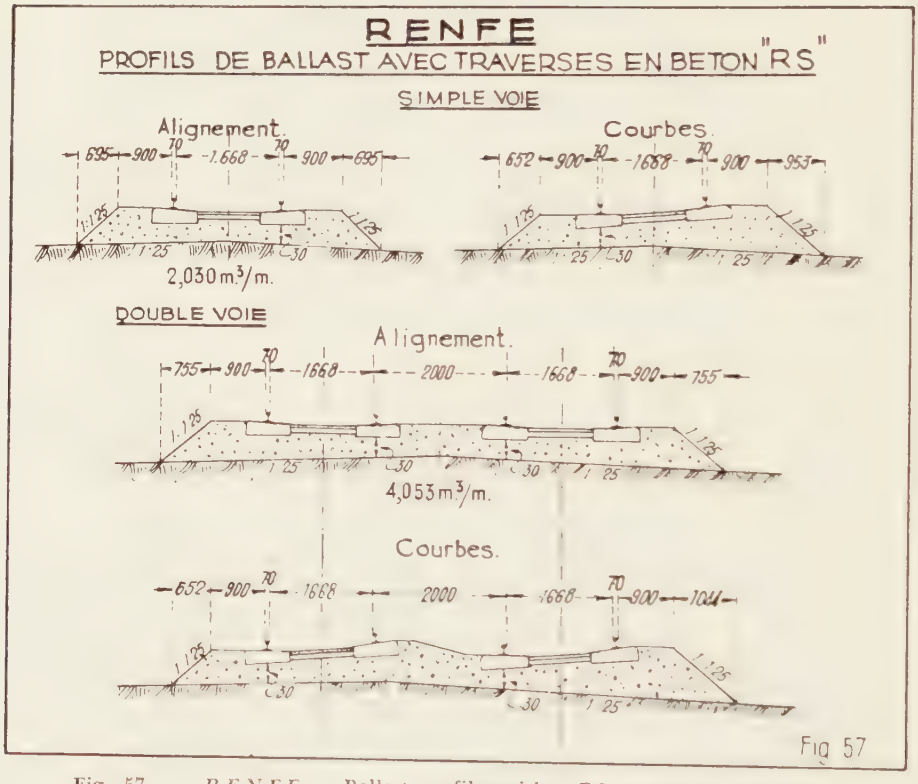


Fig. 57. — *R.E.N.F.E. :* Ballast profiles with « RS » concrete sleepers.

N. B. — Simple voie = single track. — Alignement = straight sections. — Courbes = curves. — Double voie = double track.

4.8. — *Is any speed restriction imposed on track in which L.W.R. have been newly laid and, if so, what is it and for how long its duration ?*

On all the Administrations, except the three mentioned below, there are no speed restrictions on newly laid L.W.R. except

The maximum speeds on the Dakar-Niger Ry. are : 80 km/h, 70 km/h for express trains and 55 km/h for the other trains. After the welded track is put into service, these speeds are restricted to 30, 20 and 10 km/h for three days, then increased to 55 km/h for all trains for about two months.

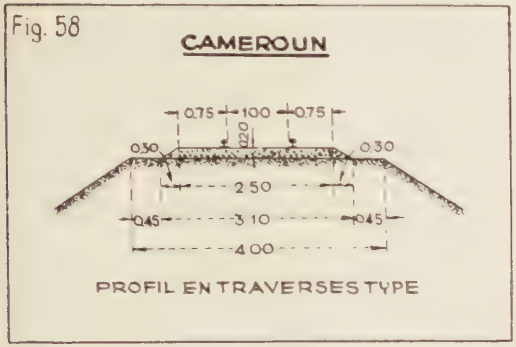


Fig. 58. — *Cameroons Rys.* : Typical cross profile.

The polish Rys. reduce the speed to 30 km/h for three days when L.W.R. are laid on new sleepers.

5. Maintenance of lines laid with long rails.

5.1. — *In view of the fact that the maintenance of lines laid with L.W.R. differs considerably from that of lines laid in the classic fashion, has your Administration prepared any technical notes regarding the special maintenance of such track?*

If so, please give an example and stress the most striking points.

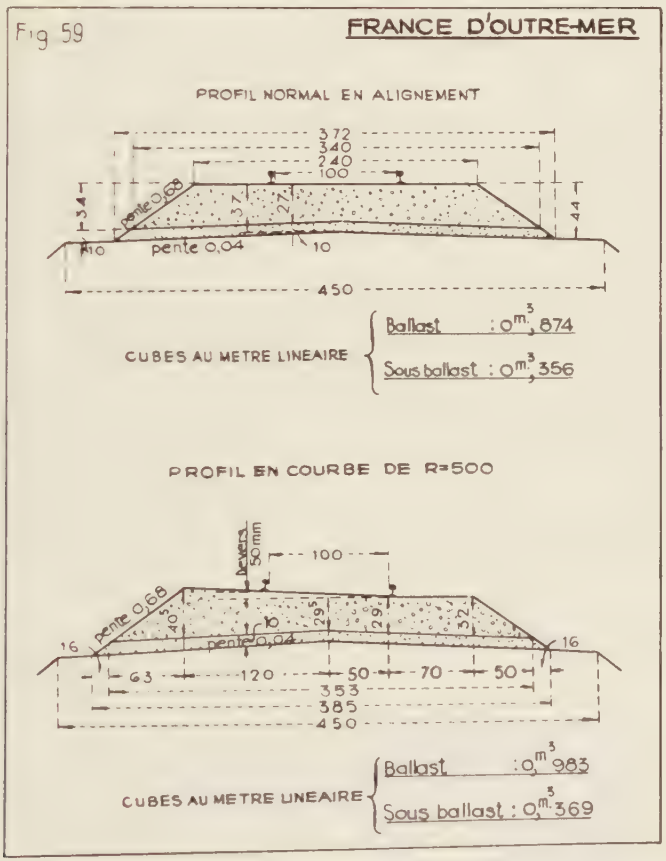


Fig. 59. — *French Overseas Rys.*

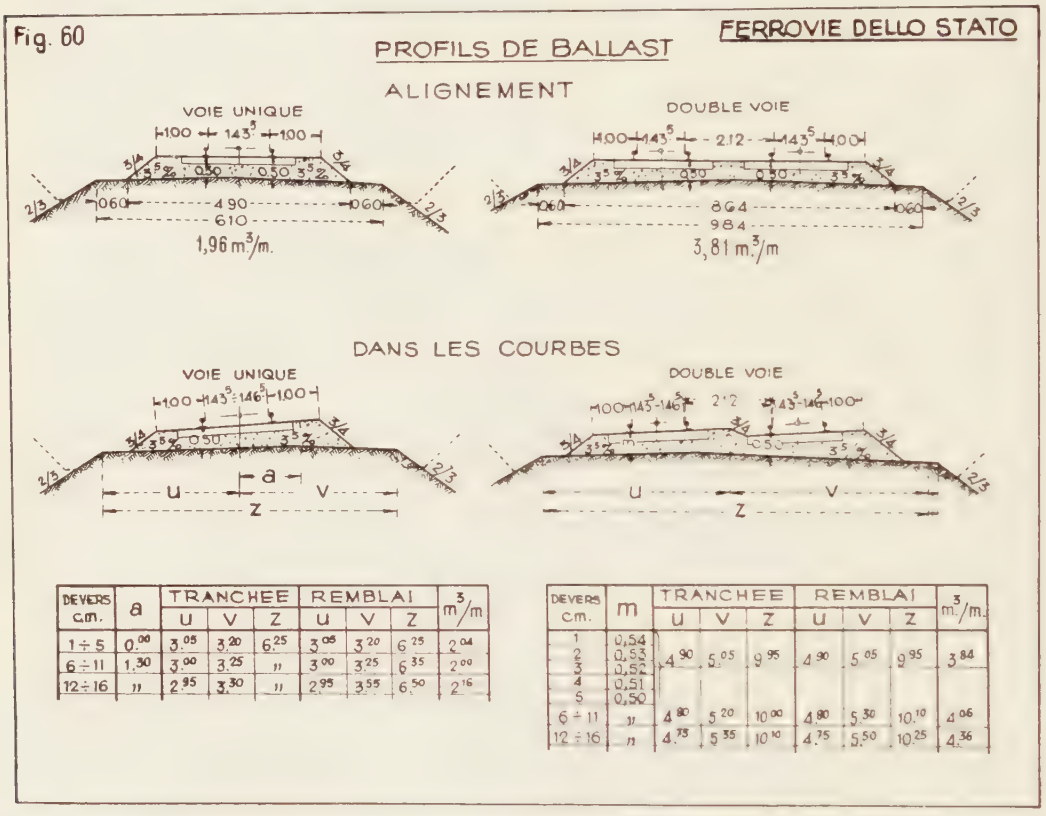
N. B. — Profil normal en alignement = standard profile on straight sections. — Pente = slope. — Cubes au mètre linéaire = cubes per linear meter. — Ballast = ballast. — Sous ballast = under ballast. — Profil en courbe de R=500 = profile on curves of R=500.

Experience of L.W.R. is not yet sufficiently long for the final regulations concerning their maintenance to be drawn up. Most of the Railways replied that laying L.W.R. has only been done so recently on their lines that so far very little maintenance has been involved and so they lack the necessary data to elaborate the final regulations.

The S.N.C.F. and Ö.B.B. have drawn up temporary technical notices regarding the maintenance of L.W.R. and the D.B. has introduced into its « Permanent Way Regulations » (1) a few clauses giving the special arrangements to be followed during maintenance operations.

The S.N.C.F. has prepared two very detailed provisional notices on L.W.R., the most important points of which are summed up below :

a. « General : the maintenance of L.W.R. must be based on the fact that they are the more stable the less work is done



DEVERS cm.	a	TRANCHEE U	TRANCHEE V	TRANCHEE Z	REMBLAI U	REMBLAI V	REMBLAI Z	m³/m
1 ÷ 5	0.00	3.05	3.20	6.25	3.05	3.20	6.25	2.04
6 ÷ 11	1.30	3.00	3.25	»	3.00	3.25	6.35	2.00
12 ÷ 16	»	2.95	3.30	»	2.95	3.55	6.50	2.16

DEVERS cm.	m	TRANCHEE U	TRANCHEE V	TRANCHEE Z	REMBLAI U	REMBLAI V	REMBLAI Z	m³/m
1	0.54							
2	0.53							
3	0.52	4.90	5.05	9.95	4.90	5.05	9.95	3.84
4	0.51							
5	0.50							
6 ÷ 11	»	4.80	5.20	10.00	4.80	5.30	10.10	4.06
12 ÷ 16	»	4.75	5.35	10.10	4.75	5.50	10.25	4.36

Fig. 60. — *Italian State Rys.* : Ballast profiles.

N. B. — Alignement = straight sections. — Voie unique = single track. — Double voie = double track. — Dans les courbes = on curves. — Dévers = superelevation. — Tranchée = cuttings. — Remblai = embankments.

(1) « Oberbauvorschriften für Vollspurbahnen » (Ob.) 1956).

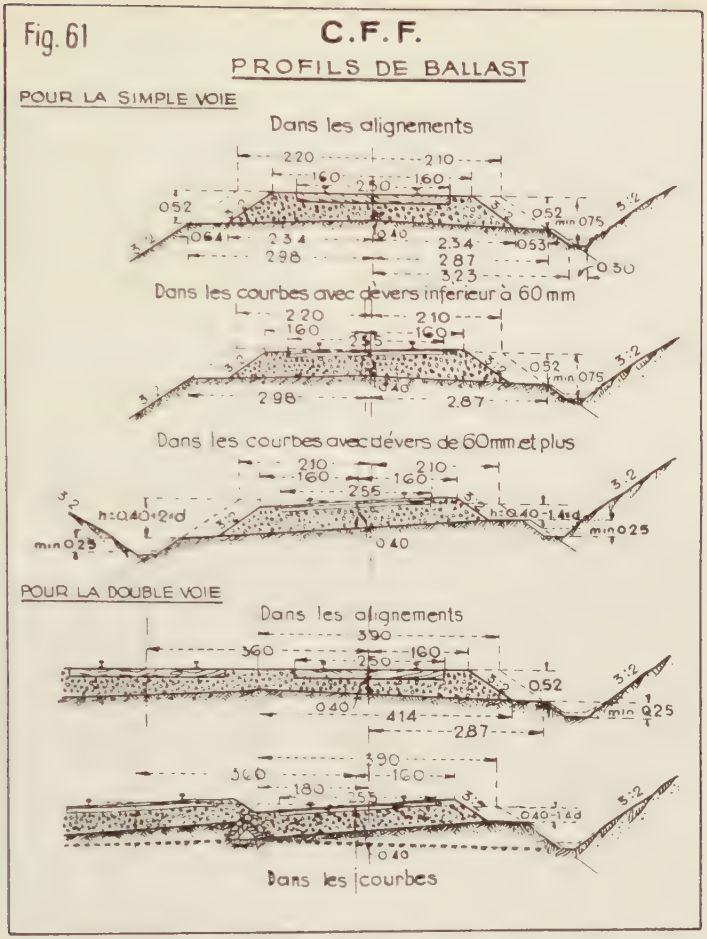


Fig. 61. — *C.F.F.* : Ballast profiles.

N. B. — Pour la simple voie = for single track. — Dans les alignements = on straight sections. — Dans les courbes avec dévers inférieur à 60 mm = on curves with superelevation of less than 60 mm. — Dans les courbes avec dévers de 60 mm et plus = on curves with superelevation of 60 mm and over. — Pour la double voie = for double track. — Dans les alignements = on straight sections. — Dans les courbes = on curves.

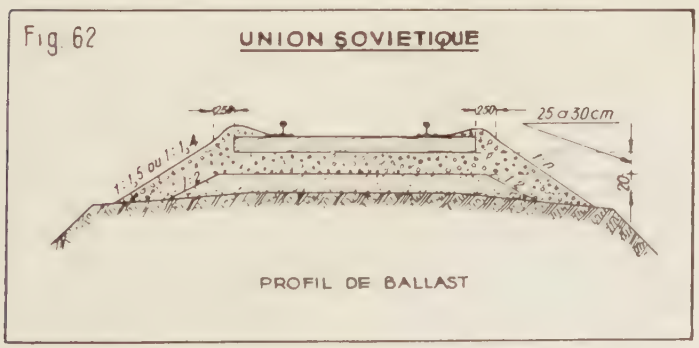


Fig. 62. — *Soviet Union.* : Ballast profile.

on them, and it must not be forgotten that lifting them up at any point by means of jacks can lead to deformations if the rails have a different temperature from that at which they were laid. The fastenings must be maintained very tight and there must be plenty of ballast, especially at the ends of the sleepers. »

be sufficient. In case of doubt, a thin feeler gauge will be used to try if it can be inserted between the upper branch of the clip and the foot of the rail near the 2nd contact. »

« The visible parts of the thread of the bolts above the screw should be protected against rust by an adhesive coating. »

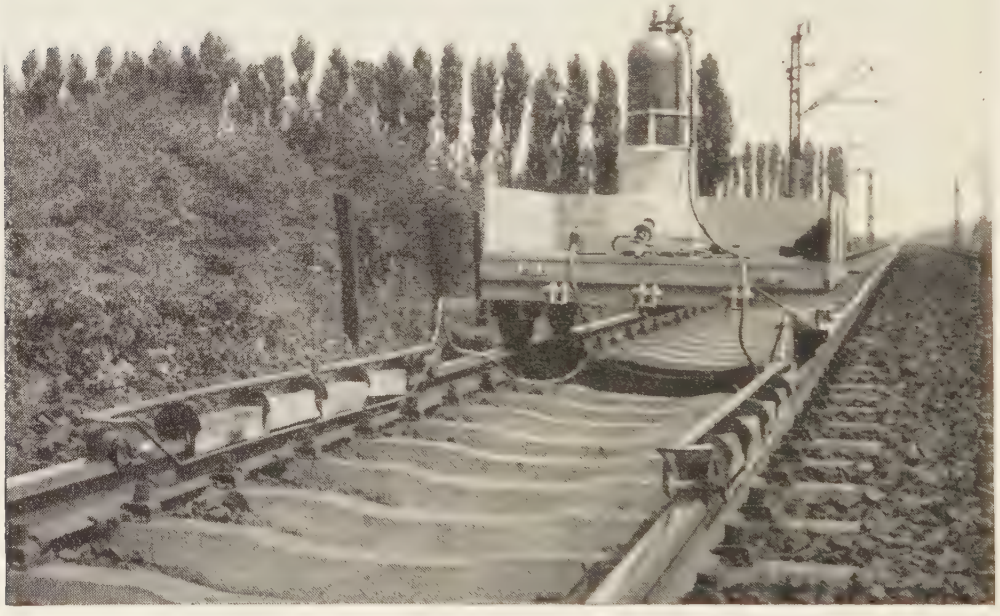


Fig. 63. — Machine for heating the rails.

b. « Tightening up the fastenings: The fastenings must be tightened up about one year after laying. Afterwards, the tightening up of the elastic clips will only be necessary when the play at the second contact amounts to 1.5 mm. General tightening up is only necessary when there is play on about 25 % of the fastenings over the length of the rail. »

« In the case of elastic clips, a check by looking at the fastening will in general

c. Levelling: « Levelling can be carried out by tamping « fichage » or showel packing Removing the ballast and lifting the track before levelling are strictly prohibited during very hot or very cold weather. Levelling must be carried out during periods of the year when there is little variation in the temperature and it remains close to that at which the line was laid. »

« Shovel packing will be carried out in

discontinuous stages over not more than 100 m at a time, and can go forward continuously provided not more than 50 % of the sleepers are uncovered at once. The parts that have not been shovel packed at the beginning, will be done in the next few days. Shovel packing should be carried out in the opposite direction in which creep is most likely to occur, in order to avoid uncovering the sleepers on the side where they risk being shifted. Finally, if speed restrictions are imposed, it is absolutely necessary to carry out shovel packing in the opposite direction to that in which the trains are running to avoid braking on track that has just been shovel packed. »

« First of all areas of 50 m on either side of the expansion equipment will be levelled just as if it was a case of lines laid with standard rails. The levelling of the middle parts of the rail will take place in the usual fashion, when the differences in temperature with the regulating temperature do not exceed certain variable amounts according to the method of levelling; this rule however is subject to the absolute temperature limits which are 0 and + 40°. »

« The following table gives the values of these differences as well as the temperature ranges within which it is possible to work in a case taken as an example, where the regulating temperature was + 25°. »

	Kind of work	*Variations allowed in relation to regulating temperature*	*Temperature ranges corresponding in the case of a rail regulated at* + **25°**
On straight sections and curves of R > 1 200 m.	Tamping without removing ballast . .	— 25° to + 15°	+ 0° to + 40°
	Discontinuous shovel packing	— 25° to + 10°	+ 0° to + 35°
	Continuous shovel packing or tamping with removal of ballast	— 20° to + 5°	+ 5° to + 30°
On curves of R < 1 200 m.	Tamping without removing ballast . .	— 25° to + 10°	+ 0° to + 35°
	Discontinuous shovel packing	— 25° to + 5°	+ 0° to + 30°
	Continuous shovel packing or tamping with removal of ballast	— 20° to + 0°	+ 5° to + 25°

« The levelling of the central part of the rail from a distance of 200 m beyond the expansion devices will be carried out a few days before that of the ends, and the progression of the work will be regulated in such a way that the sleepers on the up side compared with the running of the trains will not have their ballast removed. »

d. Broken rails : « As regards broken rails in the case of L.W.R. the Technical Notes of the S.N.C.F. lays down the difference between the temporary and final repairs. »

« Temporary repairs : if the nature of the break allows, and if the final repair can be made within a few days, consolidate the two parts with a block, fasten together with keys, impose a speed restriction on the trains, if necessary, and check the tightness of the fastenings 50 m on either side of the break. »

« If not, carry out a more careful temporary repair. To do this, taking care that no cut is made nearer than 2 m to the nearest weld, cut the rail about 2 m away from the break on either side of the break or damaged part, replace the part cut out by a 4 m long section of the same profile, with approximately the same degree of wear. »

« If at the time this is done, the temperature is higher than at laying, i.e. about 20°, the cut must be done by flame. Otherwise it can be done with a saw. »

« The fishplating is bolted to the short length and retained by the keys on the adjacent parts of the long rail. The length of the cut section is so adjusted as to leave an expansion gap at either end, according to the time of year in which the work is done. »

« Final repairs: The drilled and fishplated section must be replaced as soon as possible by a non-drilled welded section. »

« If the final repair cannot be carried out at a temperature at the rail close to the laying temperature (20° to 30°), proceed as follows: after removing the temporary section, free the stresses if any by loosening the fastenings 50 m on either side of the break, then tighten them up again and weld in the new section whose length must be 20 mm shorter than the gap. »

« If there is a risk of the final repair under the above conditions being unduly delayed, work must be done during the hottest part on the day, provided the rail temperature is a least 10°. But as the rail is then actually in tensile stress, the fastenings must not be loosened on each side of the gap to avoid increasing it uselessly and on the contrary the effectiveness of the welds is assured. As soon as the rail temperature reaches laying temperature during certain times of the day, the coachscrews can be loosened 50 m on either side and then tightened up again to spread the stresses. »

As already indicated, the D.B. has introduced in their « Permanent Way Regulations » certain rules concerning L.W.R.

In the chapter dealing with the steps to be taken to avoid deformations of the track due to changes in temperature, it is laid down that work involving removal of the ballast or loosening of the coachscrews should not be done when the rails are at a temperature of + 35° C. if at the same time the joint gap is cancelled out.

When the track consists of 30 and 45 m rails the upper temperature limit must be reduced to + 30° C.; if the rails are 60 m long, to + 25° and in the case of L.W.R. the maximum admissible temperature will be that of the rail anchorage, increased at most by + 15° C.

Shortly before the rails reach the above temperatures, work must be stopped if it is found that the compression stresses in the rails are so great that when the track is lifted slightly by means of jacks, a greater number of sleepers than usual are raised up.

In the hot season, work must be done in such a way that as soon as the rails reach the above limits, the track is already properly levelled and ballasted.

Appendix 42 of the « Permanent Way Regulations » of the D.B. is devoted to the constitution of L.W.R. and as many of these regulations have already been reported in previous chapters, in the following paragraphs we have merely dealt with the question of inspecting L.W.R.

The longitudinal and transversal displacement of sections of L.W.R. must be measured where there is any tendency for concentrations of stresses to occur; for example in changes of gradient, on curves of radius of less than 800 m in sections where braking frequently takes place, and in short sections with considerable variations of temperature such as the entry to tunnels and in the transitions between sections in the open that get a lot of sun and the cuttings.

The distance between the measurement marks must not exceed 80 m and the measurements should be taken over 100 m on either side of the section where the concentrations of stresses occur.

Buildings, the bases of posts, etc., are suitable as mark points. The first measurements should be made immediately after anchoring the L.W.R. and subsequently about every three months, but always during the hottest or coldest periods.

Breaks in L.W.R. which should be most closely watched are those in the outer line on curves.

In order to restrict the intensity of the stresses in zones adjacent to the break, on each side of it ten anticreep devices in traction are put in place and ten others in compression, starting at 5 m from the break. These anticreep devices also relieve the bolts of the fishplates.

The welds to be made to replace the section of L.W.R. which has to be repaired must be carried out at anchoring temperature + 5° C. Before beginning to weld, the stresses in the L.W.R. must be freed on each side of the break, over a length equal in metres to double the gap produced, expressed in m, increased by 20 m. I.e. if the opening in the break is 20 mm, the stresses are freed as follows : $2 \times 20 + 20 = 60$ m on each side of the break.

The specifications of the Ö.B.B. are similar to those of the D.B.

The S.N.C.B. has published for the use of its employees a short note in which it is forbidden to level L.W.R. by measured shovel packing, except with the consent of the Permanent Way department. Levelling must be done by mechanical tamping, but this must not be done when the temperature of the rail exceeds + 25° C. Care must be taken to see that the profile of the ballast is properly filled out and that the fastenings are tight, especially during hot weather.

The C.F.F. have forbidden maintenance by shovel packing of L.W.R. owing to the reduction in the lateral resistance which this causes.

The Soviet Union has drawn up some temporary instructions for the maintenance of trial sections. On those that are periodically regulated, no work must be done which might affect the stability of the track when the temperature of the rail exceeds the temperature of the last regulation by 10° C. On L.W.R. with automatic expansion, work of all kinds can be done at all temperatures.

On the Dakar-Niger Ry. new regulations are under consideration which will take into account alterations in the constitution of the track : continuous welding from station to station and continuous tamping, which will enable them to form gangs for sections of 50 km.

5.2. — *Are defects in level occurring in service corrected by means of mechanical tamping or shovel packing? What advantages and what drawbacks have you found in these two methods?*

As mechanical tamping makes the supporting surfaces of the sleepers rougher than shovel packing, owing to the fact that with this latter method owing to the vibrations the gravel is shaken down into the hollows leaving a smooth upper surface, most Administrations correct faults in level in L.W.R. by means of mechanical tamping. In addition, this method increases resistance to shifting.

This method is followed by the D.B., S.N.C.F., Matadi-Leo Ry. in the case of steel sleepers, Danish Rys., Algerian, Cameroons, Dakar - Niger, Netherlands, U.S.S.R., C.F.F. and Rhaetian Ry.

The Ö.B.B., S.N.C.F., R.E.N.F.E., Italian, Luxemburg and Tunisian Rys. use both mechanical tamping and shovel packing.

On the Ö.B.B. when the sleepers are laid on bands of gravel, the correction of the level is done by measured shovel packing; on the other hand, when the sleepers rest on ordinary ballast, mechanical tamping is used, since if this method was used in the first case, the gravel would be mixed in with the ballast.

On the S.N.C.F., a few weeks after the track is laid, mechanical tamping is carried out by a tamper on rails, in order

to obtain rapid consolidation. Correction of defects in level is done by shovel packing or by light individual tampers.

The R.E.N.F.E. acts in a similar manner and carries out a second tamping one month after laying. The two operations are done by means of MATISA tampers and the correction of defects occurring in service is done by means of individual JACKSON tampers or by measured shovel packing.

According to the S.N.C.F., shovel packing makes it possible to get a finer and more durable result at lower cost, but the precautions to be taken are rather more severe in the case of continuous shovel packing and in certain cases — when light railcars have to pass over the sections first — the mechanical tamper can be better than continuous shovel packing. Discontinuous shovel packing is very economical and tends to increase as the staff are trained in this method.

The S.N.C.L. uses shovel packing during periods when the temperature remains constant.

The Polish Rys. are of the opinion that corrections of the level should be done by shovel packing, but as they are not equipped for this, they use tamping by hand.

The Czechoslovakian State Rys. correct defects in level by shovel packing, but as this method is not widely used, the L.W.R. are tamped by hand when it is absolutely necessary to carry out corrections during hot periods.

On the Matadi-Leo Ry., instructions have been issued forbidding the use of mechanical tampers for RS concrete sleepers, in view of the relative displacement between the isolating plate and the clip as a result of vibrations, and for this reason they are going to correct defects in level by shovel packing.

As the steel sleepers used on the metre gauge lines of the Dakar-Niger Ry. are not as wide as those on the standard gauge lines, trials of shovel packing have not given satisfaction as the gravel does not bind on the sleeper bed. This opinion is shared by the Matadi-Leo Ry. which replied that shovel packing is not possible under its steel sleepers.

5.3.1. — *What is the approximate duration of the period of stabilisation of long rails? During this period what is the number of platelayer-hours per km required for correct maintenance?*

The duration of the period of stabilisation of L.W.R. depends upon the amount of traffic, the condition of the formation, the nature and quality of the components of the track and the care taken in laying it. It is not surprising therefore that with so many variables, the replies from the different Administrations are not precisely in agreement.

According to the D.B., with a good subsoil and well made ballasting, the stability of track laid with L.W.R. is suitable as soon as it is put into service, and there is no need for any retouching to improve its geometrical condition. It is sufficient to retamp and correct the line about six months after remaking it.

The S.N.C.F., in the case of average class lines, estimates the period of stabilisation as one year; the S.N.C.B. as a year and a half; the R.E.N.F.E. and the S.N.C.L. as a year; the Dakar-Niger Rys. as two or three months; the Polish Rys. as a few weeks in those cases where L.W.R. are laid on new sleepers and in the case of the C.F.F., the period varies from one to two years in the case of track laid on concrete sleepers with preliminary compacting of the ballast; it is less in the case of lines on wood or steel sleepers.

Whereas on the S.N.C.B., the period of stabilisation for L.W.R. on concrete sleepers in somewhat longer than in the case of short rails, on the Matadi-Leo Ry., it does not differ from that for sections with standard rails, and for the R.E.N.F.E. and Czechoslovakian Rys. it is shorter.

During the stabilisation period, annual maintenance of a km of line on the S.N.C.F. accounts for 500 platelayer-hours;

on the S.N.C.B. for 600 platelayer-hours if the track is laid on wood and 1 000 if it is on concrete, and on the Dakar-Niger Ry., where the duration of stabilisation is two or three months, it takes 530 platelayer-hours.

On the Matadi-Leo Ry., the period of stabilisation takes 4 444 platelayer-hours per km, but the duration of this period is not stated.

5.3.2. — *Once the period of stabilisation is over, how many platelayer-hours are required per km per annum?*

Two periods must be distinguished in the life of a line. During the first period, maintenance only involves small corrections to the level and lining and checking the tightness of fastenings, whilst in the second, the actual material has to be maintained.

As experience of L.W.R. is not very extensive as yet, at the present time, we are only in the first period, and consequently an increase in the figures given for new track must be expected.

On the D.B. the annual labour devoted to the maintenance of a km of first class line laid with L.W.R. amounts to 180 to 200 man days, i.e. 1 440 to 1 600 platelayer-hours, nearly 80 % of the maintenance costs for a line laid with 30 m rails with joints.

The S.N.C.F. estimates the labour for maintaining a km of main line as 250 hours a year, and less on average lines. The annual saving in maintenance on long welded rails compared with the classic type of track can therefore be valued at 200 hours a year per km.

The S.N.C.B. give a figure of 500 platelayer-hours for the first period of maintenance for L.W.R. on wood and 525 hours on concrete, approximately 84 % of the maintenance costs for lines laid with short rails. For the second period, they expect the figures to increase to 550 and 600 hours respectively for wood and concrete sleepers.

Most of the L.W.R. on the R.E.N.F.E. were laid during the middle of 1956 and up to the present, solely for levelling and lining up, an average of 250 platelayer-hours a year has been needed.

The Italian Rys. are of the opinion that the platelayer-hours can be reduced to 1 900 for the maintenance of one km of L.W.R., whereas 2 200 hours are needed with standard rails.

The C.F.C. on stabilised lines with L.W.R. have only had small local maintenance to carry out. In their opinion, the frequency of systematic maintenance operations would appear to be reduced by about one third.

The Dakar-Niger Ry. estimates that the 530 platelayer-hours needed during the period of stabilisation can be reduced to about 300 hours after stabilisation.

5.4. — *From your experience of the life of the component parts of track laid with L.W.R., the maintenance costs in question being known, can you give any comparison between the cost of the classic type of track and that of track laid with L.W.R., all the various factors which come into play being taken into account.*

All the Railways think that it is difficult to make any statement concerning the life of the components of lines laid with L.W.R. as they have only had a few years experience, and do not know what repercussions this type of track will have upon the rhythm of renewals.

In any case, it can be assumed that the suppression of joints increases the life of rails provided the steel remains sound. The life of sleepers cannot differ very much from that of sleepers on fishplated lines and the life of many of the types of fastenings some of which are only recent is not yet known.

In spite of all this, a summary study dealing solely with the benefits experienced in maintenance has enabled the S.N.C.F. to estimate the rate of profitability as 24 %.

The D.B. from experience acquired consider that the cost of a line laid with

L.W.R. and that of fishplated line is about 1 : 1.2, i.e. the rate of saving is 17 %. Moreover, in certain cases the adoption of L.W.R. has enabled the D.B. to increase the period between overhauls from 3 to 5 years.

In calculating the costs, the S.N.C.B. takes it that the rhythm of rail renewals is independent of that of the sleepers and that the life of the rails is 30 years in the case of L.W.R. and 20 years in the case of fishplated track. Under these conditions, the total annual cost per km for L.W.R. on wood sleepers is 56 400 Belgian frs, and that of lines with 54 m rails 66 250 Belgian frs, which gives the L.W.R. an advantage of 15 %. In the case of lines on concrete sleepers, 2 500 Belgian frs must be added to the above annual costs in both cases, so that the advantage remains about the same.

The same figure of 15 % is given by the Italian State Rys.

Experience is still too short on the R.E.N.F.E. and consequently they cannot give any figures based on valid facts; however, according to the results obtained to date with maintenance costs, they consider the advantages given by L.W.R. must be much nearer the figure quoted by the S.N.C.F. than those given by the above mentioned Administrations.

5.5. — *What incidents have occurred on sections of your system laid with L.W.R.?*

Please give a description of the most characteristic incidents and explain all the circumstances fully.

What steps have you taken to deal with fractures of L.W.R.?

It can be stated that in general incidents on sections laid with L.W.R. are few and far between and have always been caused by poor execution of the work : defective welds or tightening up the fastenings at temperatures too widely removed from the temperature laid down in the regulations.

Some Administrations have not had any incidents at all : Algerian, Cameroons, Luxemburg and Polish; on the others, the incidents which have occurred can be classed into three categories : breaks, deformations, and creep.

a) *Breaks :* Most of these have been due to badly made welds.

On the S.N.C.B. only one weld made by flash butt welding has cracked. During the night an 18 m section was cut out and replaced by a new rail of the same length and welded in its turn to the two ends. The ends of the new joints were kept at a fairly high temperature for some time after welding in order to delay the contraction due to cooling of the welds.

The expansion devices used on the S.N.C.B., whose accessories are made up of mild steel rolled and welded components, have come apart fairly frequently, but after modifying their design, it is hoped that these difficulties have been overcome.

The Matadi-Leo Ry. has recorded 12 breaks beside a weld on L.W.R. on main lines obtained by welding adjoining rails. In two cases foreign matter had got into the welds.

On the R.E.N.F.E., there was one weld that broke the day after the rail was laid and the foot of another cracked after it had been in service a year. In the first case, the opening left between the rails at the time of welding was inadequate.

The S.N.C.F. points out that the gaps which have occurred as a result of breaks have never exceeded a few cm. Their frequence in zones where second hand rails have been used has led to special checks of second hand rails included in L.W.R.

On the Dakar-Niger Ry., in addition to a certain number of breaks during the cold weather near badly made welds, there have been others which occurred near the fishplate holes on second hand rails, which were in fact due to old cracks which had not been noticed. Breaks in the middle of rails have always occurred, except in one case, on 30 kg/m Nord rails the rolling of which on the average dates back to 1880. This railway recommends that holes in rails be avoided, by making the temporary joints by fixing the foot on wood blocks by means of coachscrews, or on metal blocks by clips with screw and bolt.

The Netherlands Rys. have only had one broken rail, and the Italians a few, especially in tunnels.

In the Soviet Union, a break occurred in 1952 near the weld on a L.W.R. of 1 000 m on a line with automatic expansion according to the temperature.

On the Czechoslovakian Rys., there have been a few complete breaks at the welds and cracks.

On rails laid in 1912, the Tunisian Rys. have had defective welds due to inclusions of corindon.

b) *Deformations :* The Ö.B.B. as a result of abnormal temperatures — up to 65° C. noticed deformations the extent of which was only 2 to 8 cm. These deformations took place on straight sections.

On the D.B., two slight deformations occurred due to defects in laying. In one case, in 1952, a small deformation occurred on a curve on a single track main line, ballasted with gravel and consequently with little resistance to lateral displacement. The other deformation occurred in 1955 up the line on a bridge where there was only an 8 cm layer of ballast between the deck and the underneath of the sleepers. The line was laid in February at a temperature of 0° C. and the rails temporarily fastened to the sleepers when the temperature of the latter was 10° C., lower than the theoretical temperature. It had been intended to carry out at a later date at the proper temperature the loosening of the track, the freeing of the stresses and the final tightening up. The D.B. concludes « these examples show that suitable ballasting and tightening up at the proper temperature are essential ».

On the Matadi-Leo Ry., there was a snaking of the line because the excess length of rail had not been removed. In addition, a lift of 2 to 3 cm occurred without lateral displacement in a ravine during the hottest time of the year.

The S.N.C.F. in order to prevent a certain instability of the track in the first few days after laying, under trains giving rise to abnormal horizontal stresses, recommend that the profile of the ballast be made up as quickly as possible.

On an 8 km section of the Dakar-Niger Ry., warping of the track occurred because it was laid at too low a temperature. The rails were cut every 400 m, the stresses freed at the proper temperature, and 3 m sections of rail inserted and welded at each end and the fastenings tightened up.

In the Soviet Union, on a trial length of rail under periodic expansion, various incidents occurred during the spring of 1957; on one of the curves fairly pronounced kinks appeared, the displacement being as much as 40 mm at certain points. The causes of these incidents was the bad location of the line and the defective releasing of the stresses in the spring.

On the C.F.F., only one deformation of L.W.R. on steel sleepers has been recorded. This occurred because the rails were laid at — 5° C., i.e. 25° lower than the proper temperature, and the stresses were not freed in the spring before levelling operations were begun, while the temperature suddenly rose to + 35° C. In addition, the L.W.R. on steel sleepers require special precautions in view of the difficulty of making a compact sleeper bed right from the start with high resistance to shifting.

c) *Creep :* The only Administration to notice any creep has been the S.N.C.F. which found longitudinal displacements of a few cm after levelling had been carried out at temperatures far removed from that at which the rails were laid. This led the S.N.C.F. to fix certain limits to the temperature range outside which it is forbidden to carry out any levelling.

5.6. — *What special restrictions — if any — are imposed on ordinary maintenance work on L.W.R. sections such as packing sleepers, cleaning ballast and any other works that would disturb the stability of ballast ?*

All the Administrations agree that all operations requiring ballast to be removed from a section of line, or simultaneous

loosening of the fastenings on several sleepers should be carried out at a similar temperature to that during laying. Reballasting should be done immediately and be finished before the rails get too hot.

On the Ö.B.B. and D.B., the temperature must not exceed the temperature at which the rails were laid by more than + 15° C.; the S.N.C.F., as already stated, has fixed the temperature limits for the various maintenance operations (§ 5.1), and on the C.F.F., maintenance operations are not to be done when the temperature is higher than that at which the rails were laid.

On the S.N.C.B., as already stated, shovel packing is forbidden and has been replaced by mechanical tamping. This latter method also must not be used when the rail temperature exceeds 25° C.

On the Dakar-Niger Ry., all maintenance work must be done during the morning.

On the Polish Rys., it is forbidden to uncover for tamping a greater space than that occupied by three or four sleepers.

CONCLUSIONS.

All that we have reported above can be summed up in the following conclusions :

1) Lines laid with L.W.R. are the best solution for obtaining at one and the same time very smooth running and a large decrease in maintenance costs, a decrease which present experience still does not enable to be put at an exact figure, but which the least optimistic Administrations estimate at 15 % of the actual maintenance costs.

2) Experience of lines laid with L.W.R. is so recent that it is not yet possible to determine whether the causes giving rise to undulatory wear will occur with less intensity.

3) From the theoretical point of view, there is no limit to making L.W.R., so that the adoption of the best length is based on practical considerations. These practical considerations, however, have not been estimated in an identical way by the different Administrations as whilst some of them make their L.W.R. several km long, others limit them to about one km.

4) Most of the Administrations tend to lay their standard gauge lines with L.W.R. if the layout in plan does not include curves of less than 500 m radius when the rails are laid on concrete sleepers, and 600 to 800 m in the case of wood sleepers. In curves of lower radius than the above, the line is made up with rolled or welded rails of the length usually used by each railway, and although opinions do not agree, the present tendency is to lay these rails with staggered joints.

On metre gauge railways, the L.W.R. are laid on curves of much smaller radius, even below 200 m.

5) The method of welding which most Administrations prefer to make up L.W.R. is flash butt welding in the shops. With this much better test results can be obtained than with other methods, hollows or depressions are avoided and bosses or humps near the welds.

Thermit welding is also used extensively.

With both the above methods, there is no need to subject the welds to any kind of heat treatment after making them.

6) Opinions concerning the advisability or not of placing special expansion devices at the ends of L.W.R. are completely different from one Administration to another. These two criteria are represented respectively by the S.N.C.F. and the D.B., around whom the other railways are grouped in almost equal parts. The cost of expansion devices per km of line is relatively low.

7) All the types of fastenings which assure a strong contact between rail and sleeper can be used on lines with L.W.R. Systems like direct fastenings by coach-screws, which do not prevent relative displacement between rails and sleepers are not suitable for L.W.R. As far as elastic

spikes are concerned, experience for the moment is very limited.

8) The need to use anticreep devices in order to increase resistance to longitudinal displacement of the rails on the sleepers is disputed by certain Administrations. On the contrary, all the Railways agree that it is necessary to use a generous profile of ballast and fill in the spaces thoroughly in order to increase the transversal resistance of the track. Widening the bench beyond 1 m has practically no effect.

9) To lay L.W.R. in the track, the method preferred consists of welding up long lengths first of all in the shops and transporting these to the section being renewed where the final L.W.R. are made up by welding. The present tendency is to make up in the shops as long lengths of rails as possible with the loading and transport equipment available on each railway.

10) Although the weight of concrete sleepers makes them particularly suitable for lines laid with L.W.R., these can be laid on wood, steel and concrete sleepers as required. The same sleeper spacing is generally used with all types of sleepers, and they are laid on the same kind of ballast as that used on lines laid with standard length rails.

11) The criterion for fixing the temperature at which the final tightening up of L.W.R. must be carried out is similar on all the Administrations : either the annual average, or a temperature very close to it. The practice of heating the rails to be able to lay L.W.R. independently of atmospheric conditions is very rare.

12) The maximum speeds allowed on lines laid with L.W.R. are the same as those allowed on lines laid with standard length rails.

Likewise the speed restrictions on newly laid L.W.R. are similar to those laid down for newly laid classic type lines.

13) The short period of time that has elapsed since the intensive use of lines laid with L.W.R. has not made it possible to obtain sufficient experience regarding the mast suitable type of maintenance to adopt for this kind of line, and consequently draw up final regulations on this point. However the S.N.C.F. and the D.B. have detailed instructions which it would seem should not differ greatly from those which will be drawn up in due course in the years to come when more data will be available concerning the behaviour of L.W.R

As regards the maintaining of the level with L.W.R., a great proportion of the Administrations prefer mechanical tamping, whilst others, in addition to this method, also use shovel packing, whilst taking the necessary precautions.

14) The duration of the period of stabilisation of L.W.R. is very variable from one railway to another, and so are the number of platelayer-hours expended on them. Once this period has been passed the number of platelayer-hours expended on maintaining one km of line is considerably less than that required for the classic type of track. The most pessimistic Administrations fix the saving obtained with L.W.R. as 15 % compared with the cost for lines laid with standard rails.

15) It can be stated that the incidents which have occurred to date on sections of line laid with L.W.R. have not been numerous. Their cause has always been poor execution of the work : defective welds or tightening up at the wrong temperature.

16) Progress in technique nowadays takes place so rapidly that it is always rash to predict the future of any one of them. However, in spite of the short life of L.W.R., the results already obtained make it possible to hope that they will develop very rapidly since their use is the greatest advance made to date in permanent way technique.

Madrid, February 1958.

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INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

17th. SESSION (MADRID, 1958).

QUESTION 10.

In view of the development of light railways, what are the means to be adopted in order to reduce the operating costs of these railways and what are the resulting basic amendments ?

— Delimitation of electrification and dieselisation in relation to the traffic, capital costs and operating costs.

— Co-ordination between rail and road :

— Possibilities of mixed rail-road vehicles and of specialised vehicles for rail or road.

— Principles to be followed in regard to investment, in order to improve the returns from the capital available for the transport industry.

REPORT

(Austria, Belgium and Colony, Bulgaria, Cambodia, Czechoslovakia, Denmark, Ethiopia, Finland, France and French Union, Western Germany, Greece, Hungary, Indonesia, Italy, Lebanon, Luxemburg, Netherlands, Poland, Portugal and overseas territories, Rumania, Siam, Spain, Switzerland, Syria, Turkey, Viet-Nam and Yugoslavia),

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I. GENERAL CONSIDERATIONS ABOUT THE QUESTIONNAIRE AND THE MEANING OF « LIGHT RAILWAYS ».

1. — With the development of road transport during these last decades, the functions and even the meaning of « light railways » have undergone a profound change, so that today it is difficult to define in a precise fashion exactly what this kind of railway is compared with the ordinary type of railway.

It may be stated that whereas formerly so-called « light railways » could be distinguished above all by their constructional characteristics (curves of smaller radius,

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more frequent gradients, perhaps a smaller gauge, rails weighing less per linear metre which a priori meant that the working (speed, weight per axle, composition of the trains) was on a smaller scale, today, on the contrary, it is essentially the *lesser importance of the traffic, quite apart from the contructional characteristics,* which necessitates particularly economic methods of working, differing from those of the main lines. It therefore often happens that the expression « light railway » is taken today as being synonymous with a railway with little traffic, or even a *railway showing an operating deficit,* which is quite contrary to the original meaning.

As will be seen further on, the term secondary railway would often be more appropriate; in this way the distinction would be not between *light railways* and *ordinary railways* (a distinction concerned above all with the constructional characteristics), but between *secondary* and *main* line railways.

In any case, it is a recognised fact that the essential problem for light railways is nowadays economy of operating, and that the very existence of many of these lines depends on finding a more or less satisfactory solution to this problem. It may even be affirmed that once a minimum of safety conditions have been met, every other problem should be considered essentially from the view point of operating economy.

2. — It is obvious that this evolution in the meaning and in the problems of light railways is a direct consequence, as we already said at the beginning, of the development of road transport.

Whilst competition from these latter has not yet invaded the field of bulk transport which is the fundamental object of the main line railways, no one can deny that at the present time there is full and total competition, due to the definite coincidence of the respective fields of action of motor transport and the railway, in the case of the secondary railways. It can be affirmed that, at the present time, the secondary railways are in the front line in the struggle between road and rail, if this front line is not already becoming displaced in the direction of the main line railways. The problem (and it is a problem not only for secondary lines, but for all railways, including the main line railways) is to know if this front should be defended, and how, perhaps by sacrificing the positions most difficult to hold on to; in other words, it is question of deciding if the development of motor transport still leaves a certain margin of traffic for the different secondary lines wherein the function of the railway is irreplaceable, or at least can successfully be defended, such that it justifies the future existence of the railway for the object for which it was built, and if within these margins the volume of traffic can be dealt with by particularly economic operating systems which will make this existence materially possible.

3. — The questionnaire sent to all the Railway Administrations and Railway Organisations belonging to the *I.R.C.A.* reflects this fundamental problem. It is divided into four parts which we will briefly comment upon.

The First Part (General) is concerned with the general position of the light railways (definition, their extent compared with the ordinary lines, the object for which they were built, and their sphere of action), and above all with the evolution of these lines; in other words we wanted to learn from the different Administrations operating such railways if the original idea of a light railway is still alive, or if it has been superceded by the present transport position.

For this purpose, Part I of the questionnaire asks whether during the last 20 years any light railways have been built, or are now projected or being built; if on the existing lines there has been during the last 20 years or is now taking place any replacement of part or all the railway services by road services, or even the complete suppression of the railway line; for what reasons, according to what criteria, and with what results have such steps been taken.

This part of the questionnaire in perhaps that which touches upon the fundamental

problem, at least as far as the recent history of these lines is concerned; the replies to these questions were, as we shall see, extremely interesting.

Part II of the questionnaire is concerned with examining present conditions, from the technical and economic aspects, on our lines. This is why the Administrations were asked to give the principal technical characteristics of the line, the installations, the operating method and the rolling stock, as well — within the limits made possible by the method of accountancy used — the most important economic and statistical results. In order to have more factors of comparison between the different lines, we have endeavoured to relate the data given (passenger and freight traffic, receipts, costs, number of employees, etc.) to the mileage of the line; in addition, we have tried to make a distinction between costs which are independent of the amount of traffic and costs which vary essentially with the traffic, a distinction of fundamental importance for comparing the costs and receipts and for evaluating the degree of social utility remaining to a line.

Particular importance has been given, also in this Part II of the questionnaire, to the evolution of the operating of these lines; that is why we asked whether during the last 10 years there have been any modifications or considerable changes in the operating system, and in particular in the method of traction used, and what motives dictated the choice of any particular system.

Although incomplete as regards the statistical data, the replies to Part II of the questionnaire showed how and to what extent the Administrations have reacted to the increasing difficulty of operating such lines by adapting their methods and systems to the modified traffic situation.

Part III deals with a technical and economic rehabilitation programme for the future. The questionnaire covers all the possibilities of obtaining improvements in the operating balance sheet by means of measures taken inside the railway organisation itself, and consequently independent of the special rail-road measures and co-ordination attempts (which are the subject of Part IV); these measures follow each other in a logical scale, viz :

— Rates increases and changes to increase the receipts;

— Simplification of operating methods, independently of the system of traction used;

— Complete substitution of railway services by road services.

Particular attention is devoted in the questionnaire to an examination of the most appreciable operating economies which can be expected from changing the system of traction: in particular the comparison between diesel and electric traction is carefully examinated, both from the point of view of the operating balance sheet and taking into account other technical or practical reasons attaching to the different lines.

Part IV of the questionnaire deals, as we have already reported, with subjects essentially concerned with co-ordination (it would be better to say competition) between rail and road. Starting with the current situation (therefore the amount of competition, the possible participation of the State and railway Administrations in the management of road transport, a comparison, when possible, between rates and costs by road and by rail) two kinds of possible measures are considered :

— The limitation of competition, by means of government measures to regulate road transport, or by agreements with road undertakings, or finally by the railway Administrations themselves operating competitive road services;

— So-called active defence, i.e. definite improvement of the services, both passenger (speed, frequence, timetables, road connections between stations and town centres) and freight; in the latter case by technical measures, door to door services or delivery home, or administrative steps, such as the radical simplification of relations with clients and even appointing general intermediate agents responsible for such relations.

It will be noted that these problems, especially in the case of the freight traffic,

are very similar to those which arise in the case of main lines, and in fact the replies to the questionnaire confirmed, at least in the case of the freight traffic, the interdependence between many secondary lines and the great main line systems of which they are a part or with which they are linked up in some way even when they are run by different Administrations.

Finally, Part V deals with the essential part of co-ordination, which is the co-ordination of the capital investment as between road and railway, which should be the preliminary essential condition of co-ordination between their operating.

In particular, it is interesting to know if the road policy agrees or not with the programme of simplification and substitution of services on secondary lines, or whether these programmes follow their own different and independent path.

Obviously this final part deals with problems of the policy of transport, asking in particular for information and opinions concerning these problems, since any decisions to be taken in this field rest not with the railway Administrations but with the Governments.

II. REPLIES TO THE QUESTIONNAIRE.

1. — Seventeen replies were received to the questionnaire, two of which that of the Ispettorato Trasporti Concessi (Inspectorate of Conceded Transport, I.T.C., Italy) and that of the Swiss Transport Undertakings Union (U.E.S.T., Switzerland) related to several different lines and systems.

An examination of these replies makes it immediately apparent that so-called light railways can be grouped into three distinct categories, with a corresponding different aspect of the operating problems mentioned above :

a) Colonial type railways;

b) European lines or small systems of local interest, generally operated by private companies;

c) Secondary lines forming part of the European national railway systems generally operated by the State.

2. — Replies coming under category a) were received from :

Cameroons Railways;

French West African Railways;

Djibouti-Addis Ababa Railway;

Mediterranean-Niger Railway;

Mozambique Railway.

The replies show that even where motor transport has reached an appreciable degree of development, and in spite of the fact that some of them are in the red, the lines of this group completely meet the functions for which they were built, which are often essential functions for the country in question.

The idea of « light railway » is still alive in these cases, and the question of the continued existence of these railways is never in the balance.

3. — Replies coming under category *b*) were received from the following :

Departmental Railways (France);

Light Railways of the North (France);

Swiss Transport Undertakings Union (U.E.S.T., Switzerland), which consists of 67 lines or systems operated by different Companies, some of which, for example the Rhaetian Rys., have a considerable extent of line;

Ispettorato Trasporti Concessi (I.T.C., Italy), which consists of 42 lines or systems of various Companies, many of considerable extent, such as the North of Milan Co., the Veneta Co., the Ferrovia Circumvesuviana of Naples, the South East Rys., Calabro-Lucane, Sardinian Rys., and others;

Belgian National Light Railways.

These replies reflect the most striking and dramatic aspects of rail-road competition which involves the very survival of these railways.

The conditions of course differ from one case to another : even in the same group, there are lines which, as we shall see, still continue to fulfil essential functions and are irreplaceable. It is certain, however, that the heavy competition these lines have

to support from a system of motor transport which has already reached a very high state of development makes the problem of technical and financial rationalisation extremely urgent and imperious, even going so far as the possible abandonment of these lines and replacing them by road services.

The problem of rationalisation is aggravated by the limited financial resources of the private companies operating these lines, and consequently the need to have recourse to subsidies and allowances from the State or public organisations.

4. — Finally, in category *c*) there were the following replies :

French National Railways Company (S.N.C.F., France);

State Railways (F.S., Italy);

Austrian Federal Railways (Ö.B.B., Austria);

Greek State Railways (S.E.K. Greece);

Luxemburg National Railways Company (S.N.C.F., Luxemburg);

German Federal Railways (D.B., Western Germany);

Netherlands Railways (Holland).

Incomplete replies were also received from the Danish Railways, the Jugoslavian Railways, the Czechoslovakian Railways and the Tunisian Railways.

These replies show that the problem of secondary lines of this group are not extremely different from those which affect the lines of the previous category; however, the fact that they are operated in common with the main lines of the system often makes it impossible to judge exactly of the real position of these secondary lines, for various reasons, which as is brought down to the difficulty of insulating a single line in the accountancy and statistical data, as well as the need to judge the importance of the traffic from the point of view of this line as a feeder to the rest of the system. In addition, common operation often makes it difficult to abandon, in the case of a secondary line, the methods and system of operating applied on the main lines.

The replies received from this group in particular show that the problems raised in the questionnaire concern all the European systems, even those which did not reply, and it is very unfortunate that there were not a greater number of replies.

We think that this lack of replies can be explained, if not by the excessive length of the questionnaire, at least to some extent by the ambiguity many Administrations found in the expression « light railways » whereas, as we have already said, « secondary railways » would have been more appropriate.

During this report, we will examine the most significant points in the replies given to the various parts of the questionnaire so that we can arrive at suitable summaries for each of the above mentioned groups.

FIRST PART :

GENERAL SITUATION AND EVOLUTION OF THE LIGHT RAILWAYS.

A first group of questions covers the following subjects, general in character :

A. — Definition or other names for light railways;

B. — Extent of the light railways compared with the rest of the system;

C. — Zone of influence and object of the lines.

Replies to point A were in general lacking in precision, and confirmed the uncertainty of any definition of a « light railway ».

The replies from categories *b*) and *c*) agreed in thinking it more opportune to call them « secondary lines »; certain replies also stressed the local interest of such lines, obviously to distinguish them from the main lines of national interest. Only some of the replies in category *a*) tried to give some other indications on the terms of comparison between a light railway and an ordinary railway; these indications related to either the fact that economy of operating was the overriding factor (Cameroons) or to well defined limits to the amount of traffic (A.O.F.).

TABLE 1. — **Evolution of the light railways.**

	Present mileage		*During the last twenty years*		*Replaced by road services during the last twenty years*		*Number of motor cars per 1 000 inhabitants*
	whole system km	*secondary lines (standard gauge + narrow gauge)* km	*constructed* km	*being constructed or projected* km	*partially*	*entirely*	
a) A.O.F. (French West Africa)	4 093	— 1 241	—	50	80	—	—
Cameroons	517	— 517	—	—	—	—	4
Mozambique	2 322	— 1 320	800	539	—	—	—
Djibouti-Addis Ababa Ry.	784	— 784	—	310	—	—	—
Med.-Niger	230	— 230	230	377	—	—	—
Viet Nam	1 196	— 295	9	12	—	—	—
	9 142	4 387	1 039	1 288	80	—	—
b) I.T.C. (Italy)	5 473	2 989 + 2 484	137	107	—	1 600	29
S.N.C.V. (Belgium)	2 093	2 093	—	—	—	2 660	79
U.E.S.T. (Switzerl.)	1 945	557 + 1 388	6	—	—	100	75
C.F.D. (France)	349	16 + 333	—	—	—	1 800	116
Nord (France)	49	49			—		
	9 909	9 909	143	107	—	6 160	
c) S.N.C.F. (France)	40 990	10 200 —	—	—	7 700	4 000	116
F.S. (Italy)	17 083	4 660 + 590	120	—	—	181	29
Ö.B.B. (Austria)	6 020	1 851 + 1 435	—	—	80	70	37
S.E.K. (Greece)	1 726	— 205	—	—	—	60	7
C.F.L. (Luxemburg)	505	138 —	—	—	7	150	101
N.S. (Netherlands)	3 178	— —	—	—	360	212	46
D.B. (Western Germany)	30 459	11 706 —	—	—	470	170	62
	99 961	30 785	120	—	8 617	4 840	

The data concerning the present development of the lines of the railways which replied to the questionnaire are given in the first two columns of Table I. Whereas all the systems of category *b*) and some of those of category *a*) consist entirely of light lines, there are other Administrations in category *a*) and, naturally, all those in category *c*) whose light lines are only a part of the system; to distinguish this part from the rest of the system, it is opportune to stress once again the secondary character of these lines, from the point of view of the importance of the traffic, and, if desired, from that of the importance of the services.

Table I also shows that if in the case of the secondary lines of categories *a*) and *b*) the narrow gauge predominates, for those of group *c*) on the contrary, the standard gauge predominates, as is only logical since these lines are a part of the national system.

From the replies received, it also appears that the distinction between secondary railways and extra-urban tramways is in general very clear in the case of lines of category *a*) and those of category *c*), but not for those of category *b*) where many of the secondary lines include both railways and extra-urban tramways. The distinction is founded on the fact that the line has or has not its own permanent way, and dates back to the time when such lines were built; at the present time, there are cases of lines classified as railways which have road sections, and vice versa; as a result the statistics are somewhat confused; this is the case in particular for the S.N.C.V. (Belgium) and I.T.C. (Italy).

It is in the case of point C that the replies from the three categories differ the most. Those of category *a*) clearly show the objects for which they were built still apply in their entirety. Apart from their constructional characteristics and the amount of traffic they carry, these lines meet essential objectives of the national economy of the countries served, especially the opening up of the country they pass through (definition given by Mozambique), such lines being the route by which the products of the region are conveyed to the ports, or in a more general way, to the collecting centres. More rarely, at least in the case of the railways who replied, there are strategic reasons.

In view of the preponderance of these objectives, it is easy to understand why the freight traffic is much more important than the passenger traffic in the case of lines in category *a*); we will return to this point later.

The position on lines in categories *b*) and *c*) is quite different on the other hand. It can be stated essentially that since the time they were built, the lines now known as secondary lines, have indeed met secondary needs compared with the coexistent main lines; in general these are lines serving regions with a small population, with little industrial activity, or else local services and consequently they fulfilled a need which the development of motor transport has made much less pressing.

The replies received show however that in European countries the secondary lines still fulfil an important function, which may be irreplaceable, in two cases :

1) In the case of passenger traffic : in the case of the suburban lines or systems of large towns, particularly industrial centres. Typical in this connection is the position on the North of Milan Railways or the Circumvesuvian which, although they run essentially local services, and were classified as *secondary* lines (the Circumvesuvian is a narrow gauge line), have a volume of traffic and characteristics like those of main lines;

2) In the case of freight traffic : those lines which are branch lines or important diversions whose function it is to collect and distribute traffic to or from the national system. This is the case of many secondary lines with little traffic in category *b*), but more particularly the category *c*) lines which fulfil a useful function for the system as a whole, if not for the line in itself. This typical situation, for example, is that of the South-East Railways (Italy) from the point of view of the traffic in agricultural produce, and the S.N.C.F. (France)

lines with *little traffic* which we will deal with later.

It will be seen in addition that for the category *c*) lines, and more especially for the category *b*) lines, the freight traffic is not the predominant factor, and in some cases it is declining in absolute value, especially on the narrow gauge lines, if the function mentioned under point 2) does not apply. In spite of these exceptions, it must be concluded from the replies received that lines of categories *b*) and *c*) are less essential for the life of the country concerned than those of category *a*).

2. — A second group of questions concerns more precisely the evolution of the light railways :

D. — Lines built during the last 20 years, being built, or projected. Lines that have been *simplified,* replaced or closed to traffic during the last 20 years;

E. — Simplification of the operating;

F. — Replacing lines by road services;

G. — Closing down lines completely.

The replies to this group of questions confirm the differences in the stage of evolution of the three categories, differences which are manifested in columns 3, 4, 5, and 6 of Table I.

The percentage of lines built during the last 24 years amounts to 27 % for category *a*), 1.5 % for category *b*) and 0.6 % for category *c*); the percentages of lines under construction or projected are respectively 30 %, 1 %, and zero of the lines now in operation.

On its side, the percentage of lines *completely replaced* by motor services is zero for category *a*), 38 % for category *b*) and 16 % for category *c*).

Column 7 of Table I indicates the number of motor vehicles per inhabitant : the ratio between this figure and those of the other columns is very significant.

It shows that the idea of light railway, or more exactly secondary railway, is in obvious decline in the European countries, and that a process of the revision of the operating systems has already begun.

This process is expressed in three degrees in the questionnaire : the simplification of the operating, giving up the railway services and running substitute road services, and finally closing the railway completely to traffic.

3. — The replies to point E show that simplification of the operating, as a method of reducing costs, is followed by all the railways, not only the light railways; it shows, on the other hand, that the measures adopted have as their essential object the *reduction of the staff required.*

Two kinds of measures can, however, be distinguished :

— The introduction of technical improvements intended to reduce the number of employees and hours of work (as for example increases in the average speed, or mechanization of the signalling, shunting and level crossings);

— A *different organisation of the services,* or even the *radical abandonment of certain services intended to cut down unnecessary* labour and labour that is poorly used on only used at certain hours.

The measures in the first category are perhaps those considered in greater detail in Part II of the questionnaire; the replies showed that many lines or systems, especially those of category *b*) are following this path. This is the case on the U.E.S.T. (Switzerland) and in recent times also on the I.T.C. (Italy) to which we shall return; such measures are less advanced on lines in the other categories.

The measures of the second category concern the simplification properly speaking of the services and consequently are common to all light railways, although to a lesser extent to those of category *a*).

From the replies received, it can be seen that one objective is common to all these measures, that of concentrating in *the hands of a single employee* working full time, the duties, even of various kinds, formerly carried out by several part time employees.

This is the principle at the bottom of the system of a *single traffic regulator,* which has long been used under various names, it is true, on many of the secondary European lines. With this system, traffic movements for a given section of line are concentrated in a single station where the single regulator operates; in the other stations, which are no longer staffed, the traffic duties are carried out by the train staff; the other operations (issuing tickets, consignments, handling) in the non-staffed stations are handed over to staff under special contract (tender).

From the replies received, it appears that nearly all the lines of category *c*) and many of category *b*) are operated in this way.

Some railways however have carried simplification even further. Still with the object of avoiding part time labour, they have adopted the following methods :

— In addition to the non-staffed stations, there are others which are no longer occupied at all; of the remaining jobs, part (tickets, moving the points) are handed over to the train staff; the consigning of goods to the centre stations, looking after the buildings to the nearest crossing keeper, or even to the buffet or bookstall employees. Such measures have been adopted by the S.N.C.F. (France), by certain I.T.C. lines (Italy) and on the C.F.D. (France) lines;

– The train staff is reduced by making one person responsible for various duties. The traditional subdivision : traction (engine driver), traffic (guard), administration (inspector) is simplified; usually the duties of guard and inspector are combined (S.N.C.F., I.T.C., U.E.S.T.); the driver takes over certain secondary duties, such as looking after and handling the mail and parcels.

In Switzerland (U.E.S.T.), there are many sections with a shuttle service (Pendelkomposition) over which there are no traffic duties; on these sections, everything is done by one employee (driver).

— When the above measures are not sufficient to justify retaining a certain service, then this service is suppressed : there are therefore some stations where there is no freight or no passenger service; certain trains are suppressed (for example the evening trains) and replaced by buses, which also makes it possible to close down the stations in the evening.

Measures of this type (reduction of the service in fact) have been adopted by the S.N.C.F. where the passenger services have been suppressed over 7 200 km of lines, and on certain I.T.C. systems (Soc. Veneta, Ferrovie Reggiane).

Again with the object of avoiding part time seasonal labour, the idea of common user of the employees of the three traditional departments (Traction, Operating, Permanent Way) is beginning to gain ground; for example the same non specialist men are used during the summer for maintenance of the permanent way, in winter in the shops, and in operating during seasonal peaks, etc. This system is used by the S.N.C.F., some lines of the U.E.S.T. and I.T.C., as well as the C.F.L.; it is also used by the Djibouti to Addis Ababa Railway, perhaps the only railway in category *a*) to adopt simplification measures of this type.

— Besides the use made of the staff, there is also preoccupation with the use made of the rolling stock and installations; this is why there are so many examples of the use of the same rolling stock (railcars) on lines belonging to different Administrations, particularly in the case of categories *c*) and *b*). and again of stations in common use.

In this case again we find examples in France (S.N.C.F. system in conjunction with local systems), as well as Italy (I.T.C. lines with the F.S. system) and Switzerland (Federal Railways and U.E.S.T. lines).

From the replies to this interesting Point D it can be concluded that the objective of such simplification is the permanent and continuous use of employees, and with this in view there is a *tendency to give up the traditional subdivision of the staff into departments,* as well as the classic type of traffic regulations.

These changes, which are in the course of evolution (as will be seen in Part II)

give rise to considerable difficulties particularly from the point of view of reglementation, so much so that on many railways (though this is not explicitely stated in the replies) there is opposition between the operating and the management. Such opposition is, however, apparent above all in the case of category *c*) lines within the national system; from the example of the S.N.C.F. which is undoubtedly the most advanced in such ideas, it can be stated that lines with simplified operation form a completely distinct system from the main system as regards the regulations and operating methods.

In Italy, for example, we find the opposite case; the secondary lines of the F.S. are similar as regards type and the amount of traffic to many of those of the I.T.C., but they are subject to different regulations because they belong to different Administrations, which naturally leads to different economic results (see Part II).

4. — The replies to points E and F (which obviously only concern category *b*) and *c*) lines, show that cases of abandoning the railway after replacing the services by road services are much more frequent than completely closing down.

The following general ideas emerge from the replies :

— Except in the case of a few category *a*) lines, the transport capacity is always much greater than the traffic; which may explain why there is a great difference on our lines between the average costs and marginal costs;

— Railway services that have been suppressed are generally replaced by regular passenger, luggage and parcels services: less frequently by regular freight services;

— The regular replacement services are nearly always operated by the railway administrations themselves in the case of category *b*) systems or lines, less frequently in the case of category *c*) systems. For example, whilst the Ö.B.B. (Austria) and the S.N.C.F.L. (Luxemburg) operate directly the substitute passenger and luggage motor services, the F.S. run such passenger services indirectly (by special contracts made with private firms); the S.N.C.F. also runs freight services indirectly, whilst usually leaving to private companies the passenger services (or again by means of a special charter contract).

It may be concluded that the small undertakings, both private and national, lend themselves better to the direct operating of road services than the main line railways.

— Closing down the railways and replacing it by road services is generally strongly opposed by the public and local organisations to begin with; however after some time, the public recognise the advantages of the new service which is found to be sufficient to carry all the old railway traffic; in many cases the new road services result in an increase in the passenger traffic.

In certain cases, however, precisely when the motor service is run by a different undertaking than the railway, there is a decrease in the number of services and in the traffic (C.F.D., France). This is easily understandable when it is remembered that the marginal costs of motor traffic are higher than those of the railway, which forces the road haulier to avoid unprofitable runs.

— Freight traffic on the other hand always shows a decline, even in the case when there are replacement services connecting with the stations. This is why great prudence is necessary in deciding to abandon lines with any appreciable amount of freight traffic; this also explains the 7 200 km of S.N.C.F. lines kept open *for freight traffic only*.

— The economic benefit of such substitution is always appreciable, but it is not easy to estimate it precisely from the replies received. The number of employees is usually 30 % of that of the railway.

The above should convince everyone why category *b*) and *c*) companies are so much in favour of replacing the railway services by road services.

To conclude this first part, it should be noted that in certain cases, particularly when it is question of extra-urban tramways with electric traction, that the replacement services are assured by trolley-bus (U.E.S.T., I.T.C.).

In addition, there are two Administrations who gave a criterion for replacing a railway line, but only a very general one.

The S.N.C.F. take as basis a traffic limit of 50 tkm/km and 350 passengers-km/km per day, and the I.T.C. and D.B.B. a minimum kilometric receipt related to the cost per kilometre independently of the traffic. As we shall see these two criteria are comparable.

SECOND PART :

TECHNICAL AND ECONOMIC DATA.

1. — The most important characteristics taken from the replies are summed up in Table II, as regards the layout, the track, the method of traction and operating.

This table does not need much comment. The following points may however be noted :

— Narrow gauge (1 m and 1.067 m) predominates in the case of category *a*) lines; in those of category *b*) also there are slightly more narrow gauge lines; these are generally 1 m gauge (in Italy 0.95 m); on the other hand, as it has been already noticed, standard gauge predominates in the case of category *c*) lines; the 0.75 m gauge is only used to a very limited extent, and rack sections also are very few (Austria, Italy and Switzerland);

— The Vignole rail is used almost exclusively, except in small sections on the roads where the Phoenix type is used (S.N.C.V., U.E.S.T., I.T.C., etc.); the most usual weight is 36 kg/m in the case of standard gauge (though the 27 kg rail is still widely found), those of 25, 27 and 30 kg in the case of narrow gauge;

— As regards radius of curve, apart from the mountain lines (U.E.S.T., O.B.B. and some I.T.C. lines), these radii are rarely less than 200 m in the case of standard gauge and 100 m in the case of narrow gauge; as for the maximum gradient, this generally does not exceed 30 $^{0}/_{00}$ on standard gauge lines, but may be as much as 60 (Calabro-Lucane) and 73 Bernina Ry.) on narrow gauge lines; with artificial adhesion, it is as much as 125 $^{0}/_{00}$ in Italy and up to 300 $^{0}/_{00}$ in Switzerland (Jungfrau);

— The sleepers are generally wooden, either natural oak or impregnated oak and other woods (beech); metal sleepers predominate on the A.O.F. system, the Cameroons, and the Franco-Ethiopian Railway, as well as on many lines of the U.E.S.T. system (Switzerland);

— Maintenance of the track by purely mechanical means is not very extensive; in general, the operations of screening, repacking and tamping are done by hand, whilst on the other hand such operations as drilling wooden sleepers and tightening up the coachscrews are mechanised. However, certain small systems are carrying out trials of mechanical tampers;

— On the other hand, the welding of rails, by arc welding or alumino-thermic, is fairly widespread.

In general, the saving in maintenance costs due to the smaller number of joints and the recovery of materials makes up for the cost of welding; sometimes a well carried out welding operation making the rail sections 18 or 24 m long accompanied by the restoration of the suppressed joints, makes it possible to avoid having to replace the rails on an old line. This method has been adopted with favourable results on certain Italian lines of the I.T.C. system with light 27 kgm rails.

— Except in Switzerland and Austria, and to a lesser extent in Italy and Belgium, electric traction is not widely used on the secondary lines covered by the replies, whilst steam traction is giving ground to diesel traction.

There are no lines or systems operated

completely by diesel traction except in the case of category *a*).

We will return to this point in Part III (Rehabilitation).

— The predominant traffic system, as we have already said, is that of single regulating, except in the case of certain category *a*) lines, where there are still local traffic employees because of the great distances between the stations.

— On the category *b*) and *c*) lines, there are many stations without staff; in Italy; in France and in Austria, there are also many stations without any staff at all.

— Centralised control of the points and signals is relatively little used, except on systems in category *b*) with heavy passenger traffic (again the North of Milan, Circumvesuvian, and some lines of the U.E.S.T. with particularly heavy traffic) or in a few special cases (Calabro-Lucane) where centralised control with funicular transmission is used).

The maximum speeds are relatively high (90 to 100 km/h on standard gauge lines, up to 70 and 80 on narrow gauge lines); there are however some hilly lines with difficult characteristics where the speeds are restricted to 40 to 50 km/h. However, the speeds remain low on category *a*) lines, perhaps because the timetables and services are based on the freight train requirements. It should be noted that the fact that high speeds are possible bears witness to the good condition of the permanent way for many of the lines.

2. — In Table II, are shown certain types of modern rolling stock, with diesel traction, used on our railways or in an advanced state of construction.

The following interesting conclusions can be drawn :

Amongst the diesel locomotives a single engined BB type predominates for mixed services, with an axle load of around 13 t and an installed power of 550 to 850 HP. Although the type in question takes on different forms on the various railways and for different gauges, especially as regards the type of engine (fast or semi-slow supercharged) and transmission (mechanical, hydraulic or electric), it is clear that this type meets a well defined need, which takes into account either the type of service required, or the existing superstructure. This type of locomotive which is known as the BB 13 in Italy and is the subject of an experimental standardisation (UNIFER) only differs from the corresponding O.R.E. type by its lower axle weight (13 t instead of 15);

Amongst the railcars, on the contrary, there are various types with different characteristics. It will be seen that the total adhesion BB type is also widespread as also the type B 2 (single engine) or A 1 1 A (two engined) with partial adhesion: the four wheeled type, (Uerdingen, Macchi) is also fairly widely used. The power of the railcar engines varies between 130 and 450 HP; in general, it can be stated that up to 150 HP the engines are of the standard type also used in motor traction (Fiat, Büssing), but above this power they are engines specially designed for the railway; the different powers, which vary from 200 HP (Fiat, Breda) to 300 (Renault) and 450 (Breda) show that contradictory requirements have not yet made it possible to obtain any standardisation. In Italy, experimental standardisation has been attempted, covering the type of compartments, the number and arrangement of the compartments and the length of the bodies, but not the powers;

The purchase price per ton and per HP show a certain regularity in the case of locomotives. The price per ton varies between a minimum of 6 500 Swiss francs (BB diesel-mechanical, 550 HP of the C.F.D.) and a maximum of 9 600 Swiss francs (Diesel-electric of South-East Ry.); on the other hand, the minimum for the price per HP is 440 Swiss francs (840 HP BB locomotive of the A.O.F.), whereas in the other cases it is always about 600-620 Swiss francs. One surprising



BB Diesel locomotive, motor-van type, with electric transmission, 450 HP, T.I.B.B.-O.M. construction of the « Società Veneta » (Italy).



BB Diesel locomotive with electric transmission, 610 HP, Alsthom-Sulzer construction, of the Cameroons Railways.

fact is that rigid framed locotractors, generally with rod drive, cost more per ton (up to 9 400 Swiss frs) but above all more per HP (up to 1 100 Swiss frs) than bogie locomotives.

As for railcars, their specific purchase prices (in particular the price per HP) vary too much to give any basis of evaluation. It will be noted that in any case, as is only logical, they cost more than locomotives.

It should also be noted that the prices are affected by two factors which makes precise comparison impossible : the variations in the rates of exchange for certain currencies compared with the Swiss franc, but above all the variations in prices, both materials and labour (sometimes also the imposition or not of customs duties).

3. — Table IV gives the main statistical and economic data that could be drawn from the replies received. Although the gaps in certain replies make it impossible to get an exact idea of all the compagnies taking part, the partial figures thus obtained can however give some very significant information.

The lines or systems are classified by the kilometric receipts from the *highest, downwards;* in addition, a distinction is made between lines with *predominantly freight traffic* and those with *predominantly passenger traffic.* It will be noted, as was only to be expected from what we have said in part I that there is a clear predominance of freight traffic in the case of the category *a*) lines, whereas for all the lines of categories *b*) and *c*), passenger traffic largely predominates, with very few exceptions.

Whenever possible, the table gives, in addition to the ratio (percentages) of the passenger receipts P_v and freight receipts P_t, the equivalent number of traffic units U according to the following criteria :

— tkm equiv. : $Ut = TK + \frac{VK}{n}$
(in the case of lines with freight traffic predominating);

— pass.-km equiv. : $U_v = VK + n\ TK$
(in the case of lines with passenger traffic predominating),

n being the ratio between the average receipts per TK and VK (n varies from 3 to 5 apart from a few special exceptions).

The number of U_t or U_v per km of line gives an idea of the *traffic density*; the unit product P/U of the average tariff level, or in other words, the *value* of this traffic.

The second part of the table is reserved on the contrary for the costs : the cost S per km of line and per unit of traffic, subdivided (if possible) into the fixed part (independent of the traffic) and the variable part; finally, the number of employees per km, the average cost per employee and the average receipt P per employee (receipts and costs given as usual in Swiss francs).

There is no point in stressing the extreme interest of the comparison between lines and systems in various countries and under different conditions which this table gives.

In the first place, the law of diminishing costs, characteristic of railway operation, is easily seen : from the very low passenger-km cost on the North-Milan (1.93 Swiss centimes), it goes up to 7.95 on the secondary F.S. lines and up to 8.3 on the Calabro-Lucane: there is a similar variation, though less obvious on account of the fewer examples, on lines with predominantly freight traffic. Although the figures are incomplete, there should also be a certain uniformity, at least per categories of lines, in the fixed cost per km, as well as in the variable cost per unit of traffic; however, the lack of particular details, especially (for the reasons already explained) in the case of category *c*) lines and in particular some incertainty in the accurate dividing up of the fixed and variable costs, makes it impossible to proceed to make more precise observations.

It should not be forgotten that the cost, *very roughly average*, of the unit of traffic in the case of a motor transport undertaking may be calculated to be as follows :

passenger-km by coach with 50 to 60 seats . .	3.5	Swiss centimes
tkm by 8 t motor lorry .	10	Swiss centimes
tkm by 200 t road transport unit (two drivers)	8	Swiss centimes,

(in the above values a certain coefficient of occupation and percentage of mileage unloaded have been included, as confirmed by the operating results of Italian transport undertakings).

In our opinion, the most important facts which a study of the table brings out are three in number :

— That the variable cost S/U per unit of traffic might be higher than the unit receipt P/U;

— That this variable cost might be higher than the unit traffic cost of motor transport;

— That the receipts per km do not cover the fixed cost per km.

The first fact means — and this applies in particular to freight traffic — that the tariffs may be below the marginal costs and as a result the undertaking may work at *an increasing loss* should the traffic increase; the second, that the rectifying of this abnormal tariff position is made impossible or at least problematic owing to motor competition, and that as a result the survival of the railway requires the *cost of the unit of traffic* to be reduced.

It is interesting to note that on the category *a*) lines, with the exception of the Franco-Ethiopian Railway, the second condition is fulfilled, but not the first; this situation can be explained by the fact that motor competition is still very small, but above all by the fact that there are no heavy tonnage road transports (above 8 t) nor any network of roads facilitating long distance transport. It is not fortuitous that the highest tariffs are those of the A.O.F. where effective co-ordination of transport has been put into practice thanks to an intelligent policy of agreements with road hauliers (Hirondelle operation, of which we shall speak later).

This shows the primary and essential character of the railway organisation in these countries; however, the unbalance between the unit costs of the railway and the motor service will not be able to survive if the road network, the number and organisation of motor vehicles, and above all the useful load of the lorries develops.

Moreover, the replies received from these undertakings confirm the préoccupations which have been expressed above.

The position of the Franco-Ethiopian Co. is a sure indication that as far as this line is concerned, motor competition from heavy tonnage road vehicles has already begun, in particular on the Addis Ababa-Assab highway. (See further on Table VIII.)

On the *b*) and *c*) category lines, on which passenger traffic predominates the two first conditions exist, in some cases simultaneously; however it should be noted that in general the average tariff for the passenger unit is appreciably lower (except in the special case of Switzerland) than the average cost of the passenger-km by bus. It would therefore appear possible, within the limits set by competition, to introduce tariff increases, especially in the case of the reduced tariffs granted to certain categories of passengers; but we shall see later on, what political and social difficulties oppose such a step. However, the disparity between the variable cost and the cost by motor of the passenger-km do not lead to such pessimistic considerations as in the case of the freight services, because the marginal costs can in every way be kept within the lower limits.

Much more serious for the lines on which passenger traffic predominates, is the realisation of the third condition, i.e. receipts lower than the fixed costs. This means that if the railway is completely replaced by motor services, taking it that there is equilibrium between the variable costs of the railway and the total motor transport cost, the saving in *immediate* expenses is certainly higher than the maximum loss of receipts which could occur should the new service prove inadequate.

This condition, which can also be expressed in other forms, has been taken into account in the rationalisation of the I.T.C. lines, and it may be used as a criterion to judge whether lines with very reduced traffic should be kept open; naturally appropriate sums must be included, in addition to the fixed cost, to take into account the essential expenditure on modernising the line and improving the operating.

TABLE II. — **Technical characteristics, tr**

	Kilometres			*Tracks kg/ml*		
	Standard gauge	*Narrow gauge*	*Rack Ry.*	*Standard gauge*	*Narrow gauge*	*R*
a)						
A.O.F. (French West Africa)		1 261 (1.00)			25-30	
Cameroons		517 (1.00)			27-30	
Mozambique		1 180 (1.067)			30	
		140 (0.75)			40	
Djibouti-Addis Ababa Ry.		784 (1.00)			25	
Mediterranean-Niger	230			36-44		
Viet-Nam Rys.		295 (1.00)	22		25-27	
b)						
I.T.C. (total)	2 989	2 484 (0.95)				
		(1.00)	12			
Nord-Milano	338			46		
Società Veneta	344	21 (0.95)	7	27-30	22	
Soc. Naz. Ferr. Tr.	109			36		
Sud-Est	473			27-30-36		
Circumvesuviana		133 (0.95)			30	
Calabro-Lucane		761 (0.95)	5		25	
Sardegna		835 (0.95)			21-27	
U.E.S.T. (total)	557	1 374 (1.00)	95	36-46	27-30	
		14 (0.75)				
C.F.D.	16	333 (1.00)		35	20-25	
S.N.C.V.		2 093 (1.00)			23-32	
c)						
S.N.C.F. (France)	10 200					
F.S. (Italy)	4 660	555 (0.95)	45	36	27-17	
		35 (0.75)				
Ö.B.B. (Austria)	1 851	506 (1.00)	36	36	26	
S.E.K. (Greece)		205 (1.00)			21-30	
C.F.L. (Luxemburg)	138			38		
D.B. (Western Germany)	11 706		8	34÷49		

b = wooden sleepers.
m = metal sleepers.

installations and operating systems.

Curve radius most frequent-minimum			*Gradient most frequent-maximum*			*Sleepers Number per kilometre*		
tandard gauge	*Narrow gauge*	*Rack Ry.*	*Standard gauge*	*Narrow gauge*	*Rack Ry.*	*Standard gauge*	*Narrow gauge*	*Rack Ry.*
	120			25-15			m	
	120-200			17			m (1 500)	
	120-500			20			b (1 500)	
	100-200			27-20			m (1 300)	
300-500			23-12			b (1 500)		
	100			10	120		mb	
150-300	40-100							
250-500			30-15			b (1 500)		
300	80	80	28-10		125	b (1 300)		
250-500			22-10			b (1 300)		
200-400			25-15			b (1 300)		
	100-300			27-15			b.	
	100-120			60-35	100		b.	
	80-100			28			b.	
250	17-100			73	250	m.	m. b.	
300	100		15	32			b (1 250)	
	18			80-30			b (1 400)	
180-250	100-40		35	35-70	100	b (1 250)	b (1 250)	
120-200	60-100		45-10	29-12	67-255	b.	b.	
	200			30-20			b (1 450)	
190-300			16-8			b (1 300)		
100-300			40-10			b (1 500)		

TABLE II. — **Technical characteristics, trac**

	Remarks concerning the maintenance of the permanent way	*Predominant system of traction*
a)		
A.O.F. (French West Africa)		diesel
Cameroons	welding of the joints	diesel
Mozambique	partly mechanical	steam
Djibouti-Addis Ababa Ry.	partly mechanical	diesel
Mediterranean-Niger Ry.		diesel
Viet-Nam Rys.	manua l	steam-diesel
b)		
I.T.C. (total)		
Nord Milano	partly mechanical	D. C. current 3 000 volt
Società Veneta	by hand, welding of the joints	diesel-steam
Soc. Naz. Ferr. Tr.	by hand, welding of the joints	diesel-steam
Sud-Est	partly mechanical — welding	diesel-steam
Circumvesuviana	by hand	D. C. current, 1 500 volts
Calabro-Lucane	by hand	diesel-steam
Sardegna	by hand	diesel-steam
U.E.S.T. (total)	mechanical	TE 16.7 and D. C. Single pha
C.F.D.	partly mechanical	diesel
S.N.C.V.	by hand	diesel km 879 TE km 1 214
c)		
S.N.C.F. (France)	by hand	diesel-steam
F.S. (Italy)	by hand and mechanical	diesel-steam — TE D. C.3 000
Ö.B.B. (Austria)	by hand and mechanical	TE 16.7 and D. C. Single pha
S.E.K. (Greece)	by hand	diesel-steam
C.F.L. (Luxemburg)	mechanical, welding	diesel
D.B. (Western Germany)		diesel-steam

TE = Electric traction.
D. L. = Local heads.
D. U. = Single regulator.

installations and operating systems *(continued)*.

Speed km/h		*Number of stations per 100 km*	*Stations %*			*Remarks on the traffic movement system*
senger	*Freight*		1	2	3	
	55	20	73	11	11	D. L.
	35	2-5	100	—	—	D. L.
	50	5	57	38	5	D. L.
45	30	12	35	45	20	
90	—	38	45	55	—	B. — D. U. — A. C. el.
80	50	—	—	—	—	D. U.
70-80		33	42	45	13	D. U.
90	60	19	19	28	13	D. L. — D. U.
70		40	26	74	—	D. U. — A. C. el.
70	45	29	65	35	—	D. C. — A. C. m.
70	45	20	33	67	—	D. U.
80	60	12-20	10	50	40	D. U.
70	30					
						simplified signalling
						D. U.
60	45	35	45	16	39	simplified signalling
50	25	16	30	—	70	D. U.
60	50	28	35	65	—	D. U.
60	50					

= Block.
C. al = Central electrical posts.
C. m = Central mechanical posts.

TABLE III. — Die

	Locomotives and locotractors						
	Number	Type	Weight	H. P.	Year of construct.	Cost (*) per ton	Cost (*) per H. P.
A.O.F. (French West Africa)	13 6 19	BB m BB h	52 54	840 840	1955	6 800	440
Cameroons	24	BB el	52	610	1951		
			54	730	1954	7 800	580
		CC el	66	650	1950		
	20	0.3.0 m	40	300	1950		
		0.2.0 h	22	150	1955	7 200	1 120
Djibouti-Addis Ababa Ry.	6	BB el	47	675	1955	8 900	620
	12	A1A – A1A el	50	580	1950		
	6	0.3.0 h	26	180	1955	6 100	870
Società Veneta	9	BB el	34	2 × 225	1957	8 700	660
South-East Ry.	13	BB el	52	820	1958	9 600	620
	5	0.2.0 h	26	250	1958		
Sardaigne	15	BB el	32	640	1958	10 700	540
C.F.D. (France)	3	BB m	52	550	1954	6 500	620
		BB m	65	800		8 100	660
	8	0.3.0 m	18	200	1955	9 400	840
Ferrovie Reggiane	1	BB h	48	820	1958	9 100	530
	2	0.2.0 h	26	250	1957	8 100	830
S.N.C.F.							
F.S.		BB el.	64	1 320	1957	13 000	630
Ö.B.B.		1 B 1	24	210	1953	10 000	1 110
S.E.K.							
C.F.L.							

m = with mechanical transmission.
h = with hydraulic transmission.
el = with electric transmission.
(*) = cost in Swiss francs.

on. — Rolling stock.

Railcars

Number	Type	Weight	H. P.	Year of construction	Cost per ton	Cost per H. P.
15						
3	B2 m	32	300	1950		
4	BB m	31	2 × 300	1948		
10	82 h	31	200	1957	9 300	1 460
30	B2 m	36	450	1958	10 300	850
30	BB él — m	28	2 × 145	1957	8 400	810
7	A1 m	9	150		20 000	1 270
3	BB h	34	2 × 200	1958	10 500	890
5	A1 m	13	130	1957	13 800	1 270
	A11A h	41.5	2 × 200	1957	9 600	1 000
	A11A m	32	2 × 145	1957	9 200	1 010
	A11A h	37	2 × 150	1956	8 600	1 060
	B2	48	500	1954	10 000	970
14	A11A m	32	2 × 195	1952		
	A1 m	13	130	1956	10 000	1 000
	2 × B2 h	62	2 × 220	1955	7 000	980

	Traffic			*Receipts*		
	Km	U/km freight 10^3	U/km passenger 10^3	Pv/Pm	P/km 10^3 Swiss fr.	P/U 10^{-2} Swiss fr.
Lines with predominantly freight traffic :						
Cameroons	517	234		19/81	43.0	18.4
Djibouti-Addis Ababa Ry.	784	165		10/90	21.6	13.8
Benin-Niger (A.O.F.) (French West Africa)	579	85		26/74	19.0	22.3
Conakry-Niger (A.O.F.) (French West Africa)	662	72		20/80	14.6	20.2
Mozambique	1 320	104		19/81	5.7	5.6
Lines with predominantly passenger traffic :						
Nord-Milano	228		5 030	99/1	123.3	2.4
Circumvesuviana	132		4 320	100/–	95.7	2.2
Val Seriana	35		1 400	80/20	51.6	3.6
U.E.S.T. (total)	1 945		585	59/41	46.1	7.9
Viet-Nam	1 196		583	58/42	25.6	4.4
Roma Nord	104		770	95/5	21.4	2.8
D.B. (secondary system)	11 706			62/38	14.9	
C.F.L. (secondary system)	130			54/46	11.3	
South-East Ry.	473		445	72/28	11.1	2.5
F.S. (secondary system)	4 660		427	76/24	9.9	2.3
S.E.K. (secondary system)	233		418	67/33	9.4	2.3
C.F.E.N.	49			85/15	8.7	
Calabro-Lucane — *Bari*	291		272	82/18	7.5	2.8
Calabro-Lucane — *Cosenza*	177		322	88/12	9.2	2.9
Calabro-Lucane — Other lines	293		90	95/5	3.7	4.1
C.F.D. (Ardèche Lozère.)	281			63/37	3.1	

U = equivalent traffic units.
P = total receipts.
Pv = passenger receipts.

Expenditures		*Staff*		
S/km fixed + variable 10^3 Swiss fr.	S/U fixed + variable 10^{-2} Swiss fr.	empl./km	Cost/empl. 10^3 Swiss fr.	P/empl. 10^3 Swiss fr.
15.9 + 19.7 = 35.6	6.8 + 8.4 = 15.2	6.3	4.6	6.8
12.8 + 9.7 = 22.5	7.7 + 5.9 = 13.6	3.5	4.3	6.2
13.8 + 10.6 = 24.4	16.3 + 12.5 = 28.8	2.4	6.8	7.9
10.7 + 10.8 = 21.5	14.9 + 15.0 = 29.9	2.7	4.8	5.3
42.8 + 54.7 = 97.5	0.8 + 1.1 = 1.9	7.1	7.9	17.2
34.2 + 56.9 = 91.1	0.8 + 1.3 = 2.1	8.4	7.9	11.4
23.7 + 28.6 = 52.3	1.7 + 2.0 = 3.7	4.2	7.2	12.2
45.3	7.8	3.3		15.0
9.1 + 32.5 = 41.5	1.6 + 5.4 = 7.0	5.0	5.7	5.1
7.6 + 24.3 = 31.9	1.6 + 2.6 = 4.2	3.5		
25.6		2.0		7.5
11.0 + 18.5 = 29.5	2.5 + 4.2 = 6.7	3.8	6.3	2.9
34.1	8.0		6.2	
25.1	5.9			
9.2 + 1.4 = 10.6		1.3		
				2.0
16.0 + 10.6 = 26.6	5.0 + 3.3 = 8.3	3.7	7.9	2.5
				1.0
5.7		0.7	5.8	4.2

= freight receipts.
= expenditures.

TABLE V. — **Average prime cost of power.**

	Unit cost in Swiss francs			*Average cost per kWh at the tread*		
	Fuel oil per kg	*Electric power per kWh*	*Coal per ton*	*Diesel*	*Electric traction*	*Steam*
a)						
A.O.F. (French West Africa)	0.25			0.086		
Cameroons	0.29	0.063	190	0.100	0.082	0.254
Mozambique	0.25		28	0.086		0.038
Djibouti-Addis Ababa Ry.	0.26			0.090		
Viet-Nam	0.43		83-135	0.148		0.11-0.18
b)						
France		0.064	82.5		0.082	0.110
Italy (I.T.C.)	0.55	0.10	83	0.19	0.13	0.111
Switzerland						
Belgium	0.21			0.072		
c)						
France (S.N.C.F.)						
Italy (F.S.) — (carried free of charge)	0.17	0.04	80	0.060	0.05	0.107
Austria	0.36	0.04	70	0.124	0.05	0.093
Luxemburg	0.21	0.08	83.5	0.072	0.104	0.112
Greece	0.26		105	0.090		0.140

However, it must not be forgotten that this condition is only valid in the case of lines on which the passenger traffic predominates, or in the case of narrow gauge lines, not linked up in any way with the main line system, but does not apply when the receipts also cover the freight traffic in full loads worked in common with this main line system : in such a case, in fact, the replacement of the railway service would involve a loss, not only in the receipts of the section of secondary lines, but also of those corresponding to the transport over the connecting main lines.

This important consideration is dealt with in the reply received from the D.B. (Western Germany), who make a distinction in the case of the secondary lines of the product P_1, strictly belonging to a certain local line, from the global product for the general traffic to or from this line which also affects the main lines. The difference between these two values of receipts is very considerable; whereas the receipt P_1 (that given in Table IV, i.e. 174.10^6 Swiss frs) represents 5 % of the total receipts of the D.B. system as a whole, the global receipt for the common traffic amounts to 25 %.

As giving up the railway service would probably involve losing part of the common traffic, and consequently not only its own product, but also part of the product from the main lines, the D.B. has set up a special office to estimate this loss of probable receipts for each line; for the whole of the secondary system, it amounts to 497.10^6 Swiss francs. Taking this receipt as basis, the D.B. estimates (1950 figures) the lines for which the above third condition is fulfilled to amount to 1 518 km, which in consequence should be replaced immediately.

It seems to us that this is the most logical criterion, especially when there is a considerable amount of freight traffic, for deciding to retain a line, and it is obvious that this criterion can be applied not only to category *c*) lines but also to category *b*) standard gauge lines linked up in any way with the main line system.

The limiting conditions given by the S.N.C.F. (50 tkm/km and 350 passenger-km/km daily) corresponds more or less to 50 000 freight units and 200 000 passenger units per km per annum; for average receipts equal to the costs of motor transport, these figures equal 6 to 7 000 Swiss francs of kilometric receipts. The limit is therefore less stringent than the former.

Finally, the limit of profitability given by the A.O.F. (150 000 units of freight traffic per km, corresponding to about 600 000 passenger units, with the index $n = 4$ rather than 5) would only save two railways of category *a*) and four or five of category *b*) amongst those listed in Table IV; this limit obviously means something quite different than those reported above, which are survival criteria truly speaking.

Table IV suggests other considerations and comparisons which we will leave to the reader; we will merely draw attention to the considerable difference in the unit costs for labour, and in the numbers of employees per km of line; in particular, the number of employees per km should decrease at the same time as the kilometric receipts or better still the units U/km; the irregularities in these values show the profound differences in the operating methods and the difficulties rationalisation encounters from this problem, which we will return to.

The ratio receipts/employees gives an idea of the utilisation of labour on the different administrations.

4. — Tables V and VI are also of considerable interest.

Table V gives the average values of the cost of power in the different countries for the three systems of traction used : we must point out that these averages are very general values, both as regards the unit cost and the coefficients taken as a basis for calculating the cost of the kWh at the tread. It will be noted that (except for Austria and Switzerland), there is a very slight difference in favour of electric power, but a considerable difference between diesel traction and steam traction (with the exception again of Austria); as regards this last comparison we must also add the lower value

TABLE VI. — **Savings obtained with the alteration of the traction system.**

	Consistance		*Reduction of operating costs*				*New financial charges*	
				Total expenditure				
	Staff %	*Stock* %	*Traction only*	%	*per km* (Swiss fr.)	*per train/km* (Swiss fr.)	*per km* (Swiss fr.)	*per train/km* (Swiss fr.)
a) *A.O.F. (French West Africa)* .								
Cameroons	21	60	65	24	11 500	3.6	2 950	0.95
Mozambique								
Djibouti-Addis Ababa Ry. . . .	10	61	67	12	3 450	1.8	1 600	0.85
Viet-Nam (estimated)	5	60	14	12	6 200	2.6	4 900	2.1
b) *Società Veneta*	10		50				4 340	1.0
S.N.F.T.	40	30		38	2 800	0.5	4 430	0.67
Società Val Seriana	5	11	25	11.4	5 900	0.5	3 260	0.28
Calabro-Lucane	12.2		47	31	8 300	1.6		
C.F.D.	40	30	60	50	300	1.4		
c) *S.N.C.F. (France)*					1 300	2.5		
F.S. (Italy)						1.0		
C.F.L. (Luxemburg)					10 000	1.8		
Austria						1.6		
Greece								

of the tare per unit of traffic in favour of the diesel, a figure which it is difficult to deduce from the replies.

Table VI gives, within the limits that could be deduced from the replies, the savings obtained by certain railways who have completely or partly altered the system of traction.

The results of this Table VI. as well as the other questions dealt with in the Second Part, especially those of Chapter C, will be more usefully considered in Part III, in connection with rehabilitation.

THIRD PART :

REHABILITATION PROGRAMME.

1. — A first group of questions concern :

— The present financial position (question 1);

— The possibility of improving the operating balance sheet by *tariff measures* (receipts) and by possible *simplifications* in the operating (independently of the system of traction or other important technical innovations) (A 3, 4).

As was to be expected, the replies from all three categories agree in defining the financial position as far from satisfactory. In fact, it appears from an examination of the economic data of the Second Part that only the North of Milan Railway is making a profit, whilst a small number of the others (Cameroons, Circumvesuviana) have succeeded in balancing their operating account; the very great majority in fact show a deficit.

It must be remarked here that the replies do not explicitely state whether the various Administrations enjoy subsidies from the State or public authorities, on a sufficient scale to make up the operating deficit. It can only be stated that there are two tendencies (this consideration applies above all to category *b*) lines) making up the deficit year by year on the basis of the actual figures of each annual balance sheet, or fixing an annual subsidy according to the budget estimates.

Each of the two systems has advantages and drawbacks, but there is no doubt that the former may encourage administrations to neglect economic and technical rationalisation measures. In Italy, the first system has been given up in the case of the I.T.C. conceded lines, in view of the 1952 rehabilisation law, in favour of fixed annual subsidies, which can be reviewed every three years, a possibility suggested by the continuous variations in cost of operating, especially the progressive wage increases.

As regards the *tariff problems* also, the replies are more or less unanimous in considering that from the point of view of the receipts a general increase in the tariffs would not be effective, in order to avoid losing more traffic to the motor undertakings, particularly in the case of freight. In Switzerland alone, in the case of the U.E.S.T. lines, a slight increase in the passenger tariffs is under discussion (with not much chance of success however); this situation can be explained, although the tariff level is already very high, when it is remembered that there is no competition from *public road services,* in view of the special regime of State operation in force in this country. It is remarkable, on the other hand, that the advisability of increasing the tariffs is denied even by those category *a*) systems where motor competition is only just beginning : certain Administrations (Cameroons and A.O.F.) even go so far as to state that a reduction of the tariffs might result in an increase in the receipts. Here, we obviously have a railway meeting the essential condition of developing the regions it serves, but also (A.O.F.) whose tariffs are fairly high.

Even if it is not considered that the average level of the tariffs should be raised, many Administrations consider tariff reform or better still tariff adjustment are necessary : the motives given in the various replies can be grouped into several points which we will deal with.

— For some administrations it is essential to increase the preferential passenger tariffs (students, employees, workmen's season tickets) compared with the ordinary

tariffs. A typical case is that of Italy (both I.T.C. and F.S.) where such tariffs are about 1 Swiss centime per km. It must not be forgotten, moreover, that these exceptionally low tariffs have been introduced for political and social reasons above all : very often a very low preferential rate acts as a corrective to the tendency to concentrate the population in the industrial centres, by allowing many of those who work in the centre to live in its satellite towns within a radius of some 50 miles; the harm these exceptionally low tariffs represent to the railway balance sheet is more than made up for by the saving in the capital investment that would be needed to transfer all these homes from the provinces to the city.

It should be noted that there are certain railways of a local character, especially amongst those of category *b*), on which passengers travelling at these preferential tariffs constitute more than half the total traffic; it is therefore justifiable to retain this motive as one of the fundamental reasons for the standardisation of the balance sheet of light railways, according to the criteria given in the U.I.C. publication for the main line State railways belonging to this organisation.

— With nearly all the Administrations, there is a general tendency to ask for greater liberty and flexibility as regards the tariffs, so as to adapt the cost of transport to the « optimum » level required by the route and service offered, and above all to the various conditions of competition. This idea is clearly expressed in the reply received from the S.N.C.F.

The rigidity and uniformity of the tariffs is one of the reasons for the weakness of the railway against motor transport (as we shall see more clearly in Part IV), and moreover it is obvious that this drawback is gravely resented by the category *c*) lines which are forced to apply the tariffs in force on the national system.

The category *b*) lines on the other hand have greater liberty, especially in the passenger section (Italy and Switzerland); as regards freight, one of the advantages of the small systems lies in the greater facility of negociating with clients and the possibility of fighting motor competition by the same weapons employed by the adversary; but it is obvious that in the case of traffic carried in common with the national system, the results are conditioned by the tariff policy of the latter.

In any case, it is clearly seen from the replies that even in the matter of the tariffs, the separation (formal or actual) of the management of the secondary and main line railway is definitely advisable.

2. — As regards the problem of reducing the *operating costs* by *simplification* measures, it is sufficient to repeat what we have already said in the first part :

— all the Administrations are tending towards the only measure which can appreciably affect operating costs, viz. the *reduction of the staff*, a step which is undoubtedly difficult to realise because it is unpopular and meets with hostility from the representatives of the staff, and is disliked by politicians who have to assume responsibility for corresponding measures.

The replies received, even from category *a*), all insist upon these difficulties : the problem therefore does not merely concern those countries with an excess of labour; it is a characteristic consequence of the professional training of railway employees, many of whom have great difficulty in finding jobs outside the railway.

Consequently, there is a fear that measures taken to reduce the staff will come up against obstacles very difficult to overcome.

In our opinion, there are two problems here between which a distinction should be made : one to be solved by the Railway Administrations, and the other, on the contrary, which can only be solved by the governments.

The Railway Administrations must solve the technical and administrative problem, i.e. cut down their *labour requirements*; they can also often solve the *isolated per-*

sonal or family problems of redundant staff, or those who on account of the new labour programme will have to be transferred or retrained in order to make them suitable for use in other departments or installations (for example when the different departments are combined). This is the case, for example, in Italy (and we think it is so in other countries) in the rehabilitation programme of the I.T.C. lines, where redundant staff have been put on the retirement list, courses of instruction organised for employees to train them for new duties, accommodation provided for employees that have to be transferred to new localities (system widely used by certain main line railways), and precautions taken to avoid as far as possible sudden large scale dismissals, in one word by graduating the measures to be adopted and *rigorously renouncing recruiting new staff for a few years to replace* those who leave for various reasons or because they have reached the age of retirement.

But it is obvious that it is for the Governments and not the Railway Administrations to solve the problem of burdening the community with those who have been retired before their time, as well as transferring to other profitable jobs those employees no longer needed by the railway, and also finding jobs for those who normally would have succeeded retiring railway employees.

In their turn, the railway trade unions should prove their increasing maturity of judgment and understand that the survival of many secondary lines is linked up with the possibility of reducing the number of employees required and limiting their labour costs; the railwaymen may perhaps have some temporary benefit from opposing such steps, but by doing so, they will hasten the giving up of the railway services, which will mean that most of them will loose their jobs.

Doubtless the Administrations will be able to invent new types of labour contracts; an important step has already been taken as regards the contract employees of the unstaffed stations (*advertised appointment*). Other I.T.C. undertakings in Italy are tending towards the *family contract*, which links a whole family up with the railway, the head of the family generally having a qualified job (operating, platelayer, etc.) and the other members of the family subsidiary jobs (crossing-keeper, advertised job, labourer, etc.); or again at least two members of the family have qualified jobs. This system (which could take new forms similar to agricultural contracts in type) leads to savings in the social charges and replacements; the bond between the undertaking and the family is generally advantageous as regards the utilisation and fidelity of the staff.

However, the problem of the reduction and utilisation of the staff is still the basis on which the possibility of survival of our railways rests : this is why it cannot be too often recommended to the Administrations and still more so to the government to pursue this policy with the greatest firmness and decision, and above all not to consider that the political difficulties entailed in reducing the staff is a sufficient motive to avoid taking the technical and organising methods which will lead to a better utilisation of the labour employed.

3. — A second group of questions dealt on the contrary with :

The possibility of obtaining improved operating balance sheets by radical measures of a technical nature (system of traction, installations and rolling stock) (5);

— The orientation towards diesel or electric traction, and for what motives (6-7);

— The advantages to be derived from changing the system of traction (8, 9 10, 11, 12, 13).

On these points, the Administrations unanimously consider that *diesel traction is the most suitable* for light railways. This conclusion was already borne out, as we said, by the figures given in Part II, where Switzerland alone, for special reasons, had adopted electric traction almost completely, whilst in all the other countries, the railways who are taking technical rehabilita

tion measures have generally tended to adopt diesel traction integrally.

The reason for this preference is above all economic :

— compared with steam traction, diesel traction leads to reduced traction costs (lower consumption of stores for traction and handling), but above all to better user of the traction engines and a reduction in labour requirements (higher average speeds, one driver and dead man's handle device). Whereas the reduction in actual traction costs varies from place to place according to the price of coal and fuel oil, it can be stated that the overall reduction in labour requirements may amount to 40 % (if one man driving is allowed) owing to the higher average speed and lower charge of handling;

— compared with electric traction, diesel traction shows slightly higher traction costs, but saves on the annual financial charges corresponding to the fixed installations required for electrification (about 4 to 5 000 Swiss frs per km of main line).

In Italy, where the price of fuel oil is the highest (0.55 Swiss frs kg compared with 0.10 Swiss frs per kWh for electric power at the substation), electric traction is profitable with an annual traffic of at least 20 000 gross tkm per km of line, which corresponds in round figures to 1 million tons or 4 million passengers a year over the whole distance. Table VI clearly shows that the lines or systems where the value U/km, for freight or passengers, exceeds this limit, are very few, and amongst them are precisely those which are already electrified (North of Milan, Circumvesuviana).

There may, it is true, be technical or local reasons which modify the purely economic preference.

In the case of category *a*) lines, shortage of water and (except in a few cases like that of the Cameroons) the rarity of electric power play an important role, but these reasons strengthen the preference for diesel traction.

In Europe, it is true, certain special motives of a technical nature inherent in the profile characteristics of the lines come into the picture (in particular steep gradients and in general the need to have high powers with a small engine weight) which make electric traction preferable in spite of its economic profitability, or again local reasons regarding the availability and above all the easy distribution of electric power. These two motives apply in Switzerland (on all the U.E.S.T. lines), and on some of the I.T.C. Italian lines in the mountain regions (Dolomites, Sangritana, Centovalli, etc.), lines which moreover are already electrified and where the problem of a change of traction does not arise.

There is also another case which must be taken into account in choosing the system of traction : that of the secondary lines which form an important connection, branch or complement of a larger system that has already been electrified; in this case, motives concerning uniformity of service and better user of the traction units militate in favour of the same system of electric traction, which can then be realised economically. This is the case again in Switzerland (U.E.S.T.), Austria (Ö.B.B.) and the conceded Italian lines (I.T.C.) (a typical case is that of the Cancello-Benevent line, the only one for which electrification is projected in the rehabilitation programme), and also on many of the category *c*) lines, both in Italy and France.

In Table V, we have already remarked that in many cases there is very little difference in the price of the kWh at the tread, which pushes back even further, or even makes infinite the limit of traffic for which electrification is profitable.

Finally, it must be recognised that steam traction is now quite out of date for light railways. Only Mozambique, amongst the category *a*) lines, remains faithful to it for the time being; likewise amongst the I.T.C. lines now all being converted to diesel traction, the Calabro-Lucane Railways (for freight services) and the South Sardinian Railways (which serve the Sulcis coal mining region), whilst the State Railways which still

use steam locomotives for their freight services and on their own secondary lines, have a programme for gradually replacing them with diesel locomotives, the first of which have already been put into service. In our opinion, steam traction can more easily survive on lines with heavy traffic; in countries with ample coal supplies (England, Germany, etc.) where the factor of the weight of the trains is more important than that of the speed, and where consequently the adoption of heavy diesel-electric locomotives would lead to considerable expenditure and heavy financial charges.

The replies received, on the other hand, did not give the hoped for information concerning the programme for improving the installations.

Except in the case of certain category *a*) lines (Franco-Ethiopian, Cameroons, A.O.F.), the adoption of mechanical equipment for the maintenance of the permanent way is rarely provided for; rare also are programmes for putting into service electric signalling and shunting installations.

A programme of this kind is projected, on the other hand, by the French C.F.D. lines, and for some lines included in the modernisation programme of the I.T.C. in Italy, covering above all the control and automatic signalling of level crossings, a problem which concerns both the safety of operating and the necessary manpower for shunting and supervising.

On a suburban line with very heavy traffic (Cumana, near Naples), it is proposed to install centralised traffic control (C.T.C.); on other lines (Benevant-Cancello) a system known as « mechanised regulation » which, without affecting the principles of the traffic system, speeds up and facilitates communication with the train staff and trains passing each other.

The subject of the present report does not allow of going into details about these devices.

The above mentioned Table VI also gives some values for the economies realised or expected with the different measures of simplification and transformation of the operating, and above all with changing over from steam to diesel traction. The information supplied in the various replies more or less agrees concerning the percentages for saving on labour, on the stock required and on traction costs, as well as the overall saving per train-km; on the other hand, the information related to the mileage of the line shows differences which is only logical, since this depends on the amount of traffic. Nor is there any element of comparison in the rare details concerning the financial charges, owing to the differences in the amortization periods and rates of interest.

4. — The third group of questions in Part III finally asked on what lines all rehabilitation measures were considered to be useless, so that replacement by road services or complete closing down is expected in the more or less near future (14-15).

The replies to these questions are easy to foresee from what we have reported in the First Part. Category *a*) lines are unanimously negative; although some of them (but not all) have a deficit, the predominating consideration is that of the essential nature of the service given.

All the Administrations of category *b*), on the contrary, manifested their preference for the programme of replacing the lines showing the greatest deficit by motor transport services. Sharing this point of view are the French companies (the « Chemins de fer Economiques du Nord » foresee the replacement of its last remaining line in the near future), but above all the S.N.C.V. in Belgium and the I.T.C. in Italy, who are applying such a rehabilitation programme (at the same time as the technical modernisation of the remaining lines), which has already been realised to a great extent, the characteristics of which are given in Table I. Switzerland naturally is in a special position : the same characteristics inherent in the Alpine lines which involve electric traction favour the retention of railway lines in places difficult of access, where road traffic is extremely difficult for the greater part of the year.

This idea is also expressed by the C.F.D. (France) in the case of the Ardeche line.

It should be noted that difficult climatic and atmospheric conditions result in a considerable advantage for railway operating: in the Padana Valley (Italy) the frequent mists are one of the most serious obstacles to motor traffic; this is one of the reasons why the I.T.C. decided to retain certain lines at the anti-economic limit.

An important idea is however expressed in the replies received from the category *b*) Administrations, particularly the S.N.C.V. and the I.T.C. : the opportunity of setting up combined motor and railway undertakings, with the double object of compensating, if only in part, the losses on the lines retained for reasons other than economic by the possible profits from operating the most profitable motor services, but above all to co-ordinate as effectively as possible within a given region the use of the staff, the tariffs, the routes and the timetables between railway and road transport, to the greater advantage of the public and the best general economic results.

Such an organisation can intervene under the optimum conditions without fear of competition or rivalry and replace the most costly train services by road services (for example evening, night and holiday trains which often involve costly staff movements) or effectively achieve the necessary traffic connections with the towns or with closed down stations, a thing which is manifestly impossible or extremely difficult when the two services are in two different hands.

Amongst the category *c*) railways, it will be noted that some small systems (for example Luxemburg or Holland) have obtained results comparable with those of category *b*) systems, particularly as regards the mixed type of operating. Amongst the main line railways, the S.N.C.F. in addition to the total or partial substitution already achieved, which is shown in Table I, propose to replace the passenger services on a further 2 000 km and the freight services on 600 km.

The Italian State Railways, although they have not yet realised any such substitutions to any appreciable extent, have drawn up a programme for the gradual replacement of the railway services on a good proportion of the secondary system; however, they have not yet decided which lines shall in fact be closed down and how the replacement services shall be organised.

The Austrian Railways are in much the same position as Switzerland as regards the hilly character of their lines, and this explains their prudence in making changes: here again the retention of the lines in places difficult of access is confirmed.

The position on the D.B., finally, is somewhat exceptional; the logical and accurate studies of the special office for secondary railways has shown the value of replacing completely by motor services 1 518 km of lines, but such replacements have not yet taken place in most cases on account of the adverse opinion expressed by the Federal Government, thereby involving the D.B. in a loss estimated at 6 to 13 million Swiss francs: it is obvious that this loss is considered as being of little importance (as can easily be understood) compared with the unfortunate social or economic repercussions the closing down of these lines would lead to.

Without going back to the reasons which have already been gone into several times, we will merely observe that the setting up of combined railway and road undertakings is much more difficult in the case of category *c*) lines (except in the case of small systems like Luxemburg and Austria) because these organisations are essentially local in character and consequently fit in very badly with management of a national character: this is why it is found that the question of the direct management of the replacement motor services is the subject of discussion and opposition on the part of the Government authorities (both in Italy and France), whereas on the contrary, it is the most natural and advantageous solution for small railways.

The last question (16) of Part III concerns the programme for the new distribution of the secondary lines between different railways, amalgamations of railways, exchanges of lines between the State rail-

way and private companies. No explicit replies were received on this point; it appears however from other points in the replies that a few transfers of this kind recently have taken place (Italy and France).

FOURTH PART :

RAIL AND ROAD CO-ORDINATION.

1. — A first group of questions endeavours to define the present position as regards competition between railway and road in the various countries, and more precisely :

— What other services and methods of transport there are (private motor vehicles, regular passenger services, professional or private motor freight services) and which result in the most serious competition;

— What value can be put upon the traffic lost in this way.

The replies naturally varied with the different categories. From those received from category *a*) lines, it appears that in some cases there is literally no competition (Mediterranean-Niger, Mozambique) but the mere fact that there is a parallel road already creates the initial phase of competition : *skimming the cream of the traffic* and absorbing the short distance traffic, which is apparent less from the volume of traffic lost (which may amount to a mere 10 to 20 % of the railway traffic) than from the decline in the receipts.

In the category *a*) railways, the fact which gives rise to the most concern, naturally in view of the type of traffic, occurs in the case of freight, in particular by the loss of the carriage of valuable goods *even for long distance transport,* to professional road hauliers; a typical case is that of the traffic carried on the Addis Ababa-Assab highway (870 km) in competition, as we have already said, with the Franco-Ethiopian Railway.

On the other hand, in the case of the category *a*) lines, there is no competition from regular motor services for the transport of passengers, amongst other reasons because in the countries concerned the density of population is low, or because, as in Mozambique, the services are run by the railway itself.

In the case of the European lines, whether category *b*) or *c*), it is unanimously recognised that the railway traffic suffers competition from the three kinds of road transport enumerated above, though to different extents in different countries.

First of all, it should be noted that in certain States, competition has not yet reached alarming proportions, because the development of motoring has been much slower than the industrial development during recent years : to judge from the replies received, Jugoslavia and Czechoslovakia are in this position, so that the problem of replacing the railway services does not arise in any way in these countries. There are other examples where geographical or climatic conditions help to diminish such competition as a result of the difficulties they cause to road transport (Switzerland, Austria, and parts of Italy); in general, these are northern or mountainous countries, as compared with the southern countries with their softer climates. In spite of this, competition and loss of traffic as a result cannot be avoided : from the replies received it appears that in Italy and France the traffic taken away from the secondary lines is estimated at 50 to 80 %.

It should be noted on the other hand that in the specific case of the secondary lines covered by this report, an examination of the traffic figures (quasi-general predominance of passenger traffic) shows very clearly that on the category *b*) lines, it is the freight traffic which has suffered the greatest losses; Table VII is very significant in this respect, showing comparatively for certain I.T.C. railways the traffic statistics for 1939 and 1956.

Always in the case of category *b*) lines, but also the *c*) lines, especially those with a local character, according to the concession policy in force, there may or may not be serious competition from regular motor passenger services : Switzerland and Austria on the one hand, Italy and France on the other represent opposite examples of such a policy.

TABLE VII. — Comparison of traffic statistics for 1939 and 1956.

	10^6 *Passengers-Km*			10^6 *Tons-Km*			*Ratio of receipts passengers/goods*	
	1939	1956	*variation* %	1939	1956	*variation* %	1939	1956
Nord-Milano	596	1 013	+ 82	30.2	11.5	— 62	68/32	99/1
Soc. Veneta	54	88	+ 63	14.7	4.9	— 67	55/45	75/25
SEFTA	22	61	+ 180	4.5	2.9	— 36	54/46	79/21
South-East Rys.	51	145	+ 185	48.0	8.6	— 82	50/50	72/28
Circumvesuviana	222	570	+ 157	2.9	—	— 100	96/4	100/—
Calabro-Lucane	90	145	+ 61	18.7	7.3	— 61	58/42	86/14
F.S. (whole system)	11 773	24 386	+ 106	11 554	14 707	+ 27	40/60	51/49

The competition of private light motor vehicles is particularly serious, on the other hand, in the plains with a dense network of roads and close to the towns.

2. — A second group of questions concerns the respective legal position of the railway and road undertakings (4-6) and the participation of railway undertakings in road transport.

The answers show a particular interesting aspect of road and rail competition; in category *a*) the Railway Administrations who replied were State railways (A.O.F., Cameroons, Mediterranean-Niger, Mozambique) though completely autonomous as regards Administrations and organised on a commercial basis. All these Administrations also own supplementary motor undertakings to a greater or less extent. On the other hand, the Franco-Ethiopian Railway is an exception, being managed by a private company under the control of the French and Ethiopian Governments.

In Europe, the category *b*) lines are in general, as we have already said several times, managed by private companies under concession, with government control in various forms.

In Italy, the I.T.C. is a State Administration (Ministry of Transport) which is responsible not only for the technical and financial control but also for specific matters such as: operating subsidies and contributions for work of technical modernisation and financial rehabilitation: in the last analysis for the central management of these undertakings.

The I.T.C. can in addition administer on its own behalf certain lines if the undertaking goes bankrupt or no one takes up the concession.

In Switzerland, the technical control of the undertakings is exercised by the Federal Government through a special office of the Transport Department, but the financial subsidies are for the most part allocated by the Cantons. The U.E.S.T. is an organisation for the co-ordination and representation of the different undertakings in their relations with the Federal Government and other communities.

It should be noted that the share capital of certain undertakings is also mainly owned by the Cantons, or more rarely by the Federal State; in Italy, likewise, although to a less pronounced extent, the majority of the shares of certain undertakings is held by the State through the intermediary of the organisation which collects the State contributions, known as the I.R.I. (for example the Circumvesuviana); there are also some services managed by local communities on their own behalf (Communes and Provinces) by means of municipal undertakings or share-holding companies (for example STEFER of Rome, the Ferrovia Cuamana of Naples, etc.).

In the case of France, we can only indicate that the Administrations who replied, are private share-holding companies; in general these companies are also subject to government control.

In Belgium, on the other hand, all the secondary lines which do not form part of the national main line system are run by a single organisation, the National Light Railways Company whose shares are held by the State (50 %), the Provinces (25 %) and the Communes (25 %). The company runs both railway and road services (cf. Table I) with the faculty of conceding these latter to private firms.

From all this, it can be concluded that the ever increasing financial intervention of the State and public communities has ended either in making the control and management of the State itself more substantial, or in the gradual transfer of the share capital of these services into the hands of the State or local communities : it could not be otherwise in those sections where private enterprise cannot suffice and where moreover it is not qualified to decide whether or not to continue running undertakings at a loss.

This fact can be considered as good or bad according to whether one is liberally inclined or in favour of economic directives; however another consoling fact must not be passed over in silence : in spite of the progressive accumulation of the shares in the hands of the public communities, these Administrations of category *b*), including the public enterprise par excellence the Belgian S.N.C.V., still retain in full the prerogatives and characteristics of private undertakings, with all the resultant advantages as regards simplicity and flexibility of management and relations with the public, as well as amongst other things the possibility of managing directly in the most appropriate fashion the substitution or supplementary road services.

The position of the *c*) lines is on the other hand very different. It is superfluous to insist upon the legal position of the national main line systems : it will be sufficient to observe that within the main line railways there is no administrative division between the main lines and secondary lines, even if, as in France, there is in fact a distinction as regards the operating methods and regulations, or if, as in Germany, there is a special department of the General Management for the secondary railways, responsible for carrying out studies rather than for operating. It is true, on the other hand, that the smaller the national systems (Austria, Luxemburg) the closer their characteristics and resultant advantages approximate to those of the category *b*) systems.

3. — The position of road transport undertakings differs from one country to another, as well as in the case of freight and passenger services; there is no doubt however that not only the running of individual vehicles but also the professional public transport services are mainly in the hands of private individuals.

In the European countries, the regular passenger services are generally run by well organised small and average sized undertakings, with common union and policy bonds.

Austria and Switzerland are exceptions, where the majority of the regular motor passenger services are run by the State Post Office Services.

The position as regards freight transport is still stranger : small undertakings predominate, even family or individual busi-

nesses in which the owner of the lorry is also the driver.

The organisation of the transport and getting of traffic are not assured by the operators, but by undertakings working on a wider scale (commissionaires-consignors) who deal solely with the business side, i.e. the most profitable part of road transport, leaving the carrying out of the transport, often at a loss, to the small private undertakings.

This private capillary-like organisation of motor transport may have considerable advantages over the railway method, especially from the point of view of the continual reduction in costs and the adaptation of the tariffs to each individual case.

The replies were almost unanimous in recognising that this is a consequence not of a position of special favour granted to motor transport by legislation in a given country, but rather due to the fact that its scattered nature makes it able to elude mode easily than the railway undertaking all *the technical, fiscal and administrative regulations* intended to discipline it. It is superfluous to insist here upon the possibility that the small motor transport undertaking will not respect the regulations concerning working hours of employees (especially drivers) weight and size of loads, number of seats (in the case of passenger services), as well as avoid fiscal controls on the freight carried and the possibility of using the motor vehicle for purposes other than that for which it is licensed (for example working or hiring out vehicles licensed for private use, etc.).

To this must be added what is the unique and fundamental advantage of the motor vehicle over the railway, viz. door to door service, an advantage which all road hauliers, and the more so the smaller they are, make the most of in order to satisfy their customers down to the smallest detail.

Finally, to crown this comparison between the position of the railway and motor transport from the point of view of organisation, there is the paradox of the comparative levels between prices and costs of the road and rail unit of traffic.

The replies, at least when such a comparison was possible, are nearly unanimous : even where the comparison of the costs is favourable to the railway, even when the railway reduces its own tariffs (in particular those for freight) to the actual traffic costs alone, i.e. to the upper limit of the marginal costs, resigning itself to a corresponding deficit in the fixed costs, motor transport succeeds in offering lower tariffs on the *competitive services.* Table VIII gives a few average values of this disparity. The explanation of this fact is twofold : the hauliers make up for these reduced rates by charging higher rates on services where *there is no competition from the railway* (and this observation is valid likewise in the case of the regular motor services); many of them carry out their business (this applies above all to the small lorry owners) in a precarious fashion, by working excessive hours, using their lorries beyond their load capacity, putting off maintenance and not allowing enough for depreciation, in one word by avoiding their own *business obligations* as well as the regulations covering road traffic and labour regulations.

However, this unfavourable position has led the railway world to take energetic action in its own defence, which has already begun and in its turn is impossible to stop : the old railway has taken to the road to compete directly with its enemy, sharing to an ever increasing extent in road transport. This action is undoubtedly part of *the crisis facing the secondary railways,* which has led to the replacement of many of the railway services by road services run directly by the railway undertaking : from this the road services have been extended and now concern in particular the main line railways.

Returning to what we have already said in Parts I and III, we may state that the operating of regular passenger motor services (not only of substitution but also acting as feeder or supplementary services for existing railway lines) is very frequent in the case of category *b*) undertakings. This participation has raised doubts and caused reactions amongst motor transport undertakings : a truly unique case of competition

TABLE VIII. — **Comparison of railway and road average parallel tariffs.**
(Swiss centimes)

	Passenger-km		*Ton-km*	
	railway	*motor services*	*railway*	*motor services*
A.O.F. (French West Africa)	4.5	4.0	18.0	17.0
Cameroons				
Djibouti-Addis Ababa Ry.			11.8	9.5
Mozambique Ry.	7.0	6.5	4.0	15.5
Viet-Nam	2.8	3.4	13.5	18.5
France	4.2	5.0		8.0
Italy	4.4	4.4	6.0	8.0
Switzerland				
Austria	3.7 — 4.0	4.0 — 5.3	7.0 — 8.5	8.0
Western Germany				
Luxemburg	8.5	8.5	22.5	
Greece	2.4 — 3.7	4.9	5.5	6.5

against the railway which has led the latter to repay it in its own kind !

These fears are echoed by the Governments when they represent the defence of private enterprise against State intervention : hence the opposition and uncertainty which results concerning the direct operating of regular motor services by the national railways, opposition which we have already mentioned and which, let us repeat, put the private undertakings of category *b*) in a favourable position as in their case the running of such services involves neither political nor polemic problems between directives and liberalism.

The intervention of Railway Administrations in the case of freight services is on the contrary fairly rare in the case of the small systems of category *b*), but occurs on a large scale with the national systems especially when the freight traffic is of preponderant importance. We have already given examples from category *a*) (Cameroons and A.O.F.); in Europe, there is the example of Austria (Ö.B.B.) where the Federal Administration has the right to run all the services that are in connection or supplementary to the railway services, but above all there is France (S.N.C.F.), where the participation of the State Railways Administration in motor freight transport is systematic and constitutes one of the most effective means of protecting the railway traffic. This example is particularly significant, because the S.N.C.F. by means of their subsidiary company fulfils at one and the same time the functions of carrier and consigning agent by chartering private lorry owners.

In any case, it must be recognised that the phenomenon of the participation of the Railway Administration in road traffic, the result of the crisis suffered by the secondary railways, is more or less general, and as we have already stated, irresistible, if it corresponds to a well defined programme drawn up by those responsible for the transport policy. It should also be affirmed that in the discussions of a political nature taking place when considering the advisability of handing over to the Railway Administration the replacement or supplementary road services, there should never be any question of the State versus private enterprise dilemna, but solely of the principle of improving the service offered, whether assured entirely by rail or partly by road.

4. — The third group of questions deals with the possibility of fighting road competition thanks to two kinds of measures : 1) stricter regulation and limitation of road traffic, by means of government measures or agreements between the railway administrations and road hauliers; 2) improvements to the railways services, especially by adopting supplementary rail-road vehicles and by offering the clientele better service.

As regards measures under 1), it appears from the replies that there is a general demand for imposing upon road transport minimum tariffs and maximum load limits, as well as delimitations of its radius of action in order to avoid specific competition and waste of capital investments.

It is necessary to be very clear on this point : we think that no limitation can be put upon private vehicles. These represent a conquest of motor technique and have created a new traffic which has been added to that which the collective method of transport gave rise to in its time.

Individual means of transport might therefore be required to show a greater traffic discipline, greater respect for human life and the rights of others (which are only too often overlooked at the present time), better correspondence between the fiscal charges and effective costs, for the various categories of vehicles, of the maintenance, renewal and extension of the national road network, but it would be profoundly illogical to try and limit this type of traffic in any way.

However, it is clear that the development of individual means of transport does not do away with, but on the contrary increases indirectly the need for a collective method of transport, and moreover, it is obvious that if the user can choose between individual and collective transport, it would be anti-economic for the community as a whole to keep two collective systems of transport for the same purpose that are in competition with each other.

This argument is valid in particular in the case of regular passenger services (which, as we have seen, are of particular interest to the secondary railways of Europe), and the professional transport of freight over long distances by vehicles that can carry a high tonnage, which, in consequence, have the same object as railway transport (and this concerns all the railways, both main line and secondary).

Now, in the case of the passenger motor services, which have to obtain a concession and are controlled by the government authorities as regards their operating, it should not be difficult to realise a strict co-ordination between the motor services and the railways, so as to avoid all harmful double use, but according to all the replies received, such co-ordination has only been attained in Austria and rather more in Switzerland, to such a point that the U.E.S.T. can state that the passenger motor services far from being prejudicial, are an invaluable contribution to railway traffic; in the other countries, less restrictive regulations are preferred, and doubling of the services allowed to a greater or lesser extent.

In the case of freight, it is more difficult to adopt specific measures for given services. Attempts of this sort have been made in certain countries (France, Austria, Germany); the A.O.F. co-ordination plan is of interest in this connection (« Hirondelle » operation) according to which the motor hauliers and railway make reciprocal agreements, with the result however of safeguarding against competition from lorries the most important freight traffic service on the Benin-Niger line.

It seems to us, however, from the replies on this point, that co-ordination plans, whether decided upon and imposed by the Government, or negociated between railway undertakings and road hauliers can only prove effective and result in any appreciable economic advantage for the railway if the latter has some weapon to call upon, in other words some important superiority to motor transport. This is a wise rule for any policy, not only transport policies; it is a mistake on the contrary to try and come to an agreement with nothing but lamentations and showing a defeatist attitude. Such behaviour always emboldens ones adversaries, makes the railway unpopular in

public opinion, and above all to the government, and helps in giving rise to a spirit of renunciation amongst railwaymen which leads to the progressive abandoning of positions, the beginning of a slow and inevitable decline.

We consider, in sum, that the railways cannot pretend to obtain measures of type 1), in other words co-ordination and limitation of the field of action of the road, unless they also adopt measures of type 2), i.e. « active defence » measures for their own traffic, which is the subject of questions 10 to 16 of our questionnaire.

5. — It is truly a point of satisfaction to recognise that all the secondary Railway Administrations have felt this necessity; it would be too long to enumerate all the measures taken and directives followed, as given in the replies. We will however note the main points as usual.

In the case of *passenger services,* the most effective measure (apart, obviously, from the level of tariffs) is the improvement of the service itself; from the point of view of competition, therefore, the most must be made of the best characteristics of railway services : safety, regularity, speed, to which we must add, in order to win the favour of the public : frequency and convenience. It is possible to obtain all these on the secondary railways with services using motor units, or better still completely replacing steam traction.

However, the simple measure of changing the method of traction will not be sufficient to attain the objectives listed above : the category *a*) lines have considered that they should stress the idea of comfort (for example by introducing couchettes on the night trains); other undertakings, particularly those of category *b*), offer auxiliary services which are much liked by the public (for example storing or carrying bicycles, car parks in the railway premises).

But above all, in the case which most concerns *b*) and *c*) lines, i.e. local traffic, the following factors play an important part in attracting the traffic : careful choice of timetables, respecting the hours at which people have to travel (employees, students and workmen) and building stations and halts as close as possible to the places where people live and work.

Under other traffic conditions, it is extremely important to abolish or reduce to the minimum changes of train, which the public usually dislike very much. Certain category *b*) undertakings have arranged day return services linking up the provinces to the large towns, or again two main places in the provinces, by means of railcars running over different sections of lines, even belonging to different Administrations; in other cases the combined motor-railway Administrations take the motors right into the stations to facilitate the inevitable changes from rail to road.

These are apparently insignificant measures, but they are important because they make the public like the railway, and in particular that part of the public which forms the greater part of its custom, and they must be studied in each particular case and the management must show a spirit of adaptation and great mental flexibility in order to make the most of all the possibilities of the railway. We cannot insist too strongly that everything possible must be done in this direction.

More numerous and more complex are the measures to be taken in the case of freight. Amongst these we may mention : supplementary door to door services or by means of special rail-road vehicles; rapid methods of loading and unloading, a policy of agreements, and relations with clients.

On lines of category *a*), the special measures have been developed very little (the Cameroons are experimenting with the piggy-back), and likewise supplementary transport in general, apart from collecting and grouping the parcels traffic. A special situation exists on the Franco-Ethiopian Railway where supplementary transport is hindered by the customs in the case of freight on arrival.

On the other hand, on the A.O.F. and Cameroons Railways, the development of industrial sidings is particularly important, and in particular the setting up of stores

and depots on sidings which are rented to clients. On these systems, this traffic represents nearly half the total. This measure is only one aspect of the problem of relations with clients, which these railways are sometimes developing in an original way by means of special agreements, storage, penalty rates, credit accounts, considerable use of motor transport by means of associated companies : indices that these Administrations enjoy much greater freedom in this field than many European systems. It should be noted that the A.O.F. also makes use of its own general agency, to which it hands over all or the greater part of its dealings with clients.

In the case of the European lines, whether they belong to category *b*) or category *c*), it must be recognised first of all that the local short distance freight traffic is doomed to disappear (if it has not already disappeared) and consequently all their attention should be concentrated on the traffic connecting with the main line railway, the secondary lines being considered (from the point of view of freight traffic, and naturally when they are standard gauge) as distribution sections or connecting sidings for important clients.

The supplementary transport should therefore be considered from this aspect, in the sense that the acquisition of traffic by the secondary lines (even those of category *b*) which belong to a different administration) is essential to the *benefit of the national system.*

In the case of *parcels traffic*, the collection and delivery are effected by the railway undertakings by means of motor vehicles (haulage) on certain railways systematically. It should be noted that many large railways (led by the S.N.C.F.) have tended towards organising large collecting centres, limiting the railway transport to the main arteries, and using motor lorries for the terminal runs around the main centre. This system has sometimes taken away the parcels traffic on secondary lines of limited length.

There are however still many secondary lines which connect with at least one or two important centres which might have a considerable parcels traffic, and in cases of this sort, the Administrations are equipped for transport by lorries (if needs be by charter from private firms).

Mistakenly, in our opinion, certain Administrations neglect the parcels traffic : this is one of the most paying traffics from the tariff point of view, which feeds the most important consigning agencies and road hauliers, but it is above all a type of traffic for which the lorry cannot invoke the usual claim of superiority, because even in the case of road services, collection and warehousing means transhipping from the big lorries to smaller vehicles for delivery. The essential conditions to overcome road competition are speed of delivery, simplicity of relations with clients and in the tariffs, consequently problems of organisation which often require an efficient agency service and distribution by lorries.

In the case of full loads, special mention must be made in particular amongst the special vehicles for delivery home :

1) Those which take the freight the whole length of the railway transport (consequently containers, the piggy-back, the pallet, the latter in particular becoming widely used);

2) Those which, on the other hand, are only used for the road journey (wagon-carrying trucks, and obviously motor lorries).

The replies show that special vehicles are rarely owned by the secondary lines but more often by the national systems, or again by subsidiary companies equipped for this purpose, or by clients themselves; but the secondary lines should be equipped for loading, unloading and transporting such vehicles; their efficiency in this connection can but reflect upon the efficiency of the main line system; in particular, the problem of the *cost* of such services certainly cannot be solved by the secondary lines.

It may happen, on the other hand, that secondary railways find it profitable (for example the Ferrovie Sud-Est) to equip themselves with some wagon-carrying trucks,

but the replies on this point did not agree, and show (for example C.F.D.) a preference for equipment of the first type. We think that the diversity of possibilities does not allow of formulating any general rules; however if the full load traffic is to be safeguarded, nothing should be left untried.

A system which merits particular mention in this connection is that of the « transporter bogies » used by the Calabro-Lucane Railways so that they can carry standard gauge wagons from the F.S. on their 0.95 m gauge lines; this system is now being used, with some modifications, on the narrow gauge secondary lines of Sardinia. This is an interesting experiment to save the remaining freight traffic on these lines.

One point on which the replies received even from category *b*) and *c*) lines show remarkable unanimity is the advisability of increasing as much as possible private sidings, as well as giving such clients better service.

For this purpose it is not rare to find Administrations of category *b*) owning special wagons for certain predominant types of transport (for example tank wagons, or refrigerated wagons, as is the case on certain Swiss and Italian lines); many replies also show that there is a tendency to bind such clients to the railway by means of favourable contracts provided he guarantees a minimum traffic. This attempt is not always crowned with success owing to the distrust with which clients look upon such an obligation.

6. — In the Third Part we have already dealt with the advisability of simplifying the tariffs. It can be repeated here that as far as the parcels traffic is concerned, the secondary lines are tied up with the tariff position on the main line system.

Many of the replies insisted on the need to simplify relations with clients and make general agencies responsible for commercial relations with clients.

In the case of the main line railways, this tendency is more than understandable; they do not think that traffic can be obtained by railway officials whose mentality is too far removed from that needed under conditions of intense competition; the presence of an intermediary armed with certain given powers between the railway and the client may overcome and solve in each case all the difficulties which still militate against simple relations such as those obtaining on the road.

But undertakings of category *b*) have a much more flexible structure which makes them capable of dealing with the commercial side themselves, and even of acting as agent between the client and the national system. For this, however, it is essential to have cordial relations and the greatest confidence between the main line Administration and the private secondary Administration based on the idea that the railway front is one and undivided no matter which Administration is responsible for the different sections of the system.

FIFTH PART :

CO-ORDINATION OF INVESTMENTS.

1. — It has already been said that it is not possible to draw any very precise conclusions from this last part of the questionnaire, because the problems with which it deals are for the most part outside the jurisdiction of the Administrations.

To the first question concerning the sources of capital for the development of railways and road transport, the replies were practically unanimous in recognising that the State and other local communities granting the concession [case of many category *b*) systems] are the main sources of capital for increased investments and renewals of the railway system. There are however examples of cases in which the satisfactory financial position of certain Railway Administrations allows them to meet capital investments themselves; the North of Milan for example has carried out the electrification of its system without recourse to the State; in the same way several category *a*) railways have been able to meet the cost of purchasing new Diesel stock from operating re-

ceipts; there are also category *b*) systems which meet the cost of renewals themselves; it should also be noted that in many cases the assistance from the State or communities only covers part of the cost (I.T.C. and U.E.S.T.).

Again it is the State and communities who finance in general the construction and renewal of the road network; there are, however, examples, in certain European countries, of motor roads built wholly or in part with the assistance of private capital.

On the other hand, for obvious reasons, the capital for the increase and renewal of the road vehicles is private in origin; the only exception is transport undertakings belonging to the national railway systems.

However, it is clear that the distinctions listed above are not essential; in effect, even when the capital is supplied by private individuals, there are always average or long term banking operations, often guaranteed by the State or local communities. In sum, there is always recourse, often on a large scale, to the national revenue; the problem is therefore less that of the identity of the provider of the necessary capital than the proper utilisation of the credits asked for.

From the replies received, it appears more important, from this same point of view, whether or not road and rail come under the same government authority or under different authorities. It is the same for the State operated systems of category *a*) (A.O.F., Cameroons, Mozambique) as well as for certain European States as regards the operating; it is not so in general in the case of construction; a rare and perhaps disadvantageous case is that where the operating and the regulation of road traffic on the one hand, construction and renewal of the roads on the other (above all the initiative for and control of capital investments) depend on different authorities (Italy).

It will be noted however that in Austria and in Switzerland, railway and regular road services are operated by the State but depend upon different authorities (Ministry of Transport and Post Office), there is strict and effective co-ordination.

Questions 3, 4 and 5 finally bear upon the essential point of the question : the co-ordination of capital investments and orientation of policy for the future development of these two types of transport.

The orientation of the railways, which also appears from the replies received : progressive abandoning of lines with little traffic to concentrate the capital investment upon the essential system, or rather on the lines (whether or the light or ordinary type) which carry the essential traffic : passengers in mass, freight in bulk and over long distances. An obvious requirement of such co-ordination will therefore counsel :

1) Developing the extent and improving the quality of the penetrating road network, in order to carry the replacement traffic (passenger and freight) of the secondary lines to be closed down, rather than create new, long highways for heavy motor transport, parallel to the main lines of the great railways;
2) Guiding motor construction and road traffic regulations towards a limitation of dimensions and loads, so as to avoid the development of heavy tonnage motor vehicles and trailers, whose presence on the roads is the cause of the insufficiency of the road network, and requires capital to be spent on new roads to a much greater extent than is necessary for the private traffic and that of vehicles of average tonnage.

The replies confirm that the situation is far from being encouraging : in certain European States (Italy, France, Germany) unlike in others (Switzerland, Austria) 20 t traffic is overloading the road network precisely on the routes where the railway is working below its traffic capacity. There is no need for any profound studies into the economics of transport to affirm that restoring such traffic to the railway would reduce the unit cost of transport, whilst on the contrary an increase of such road traffic will involve important capital investments in roads suitable for lorries; in the same way, it is easy to see that the continuous and increasing skimming off of the cream of the railway traffic by the road will lead

to an ever deteriorating financial position on the great national railway systems, without it even being conceivable that even one of these main lines can be replaced : the difficulties in the way of replacing lines with much smaller traffic are in fact already numerous.

There is no doubt that this is a problem for the Government and not for the Railway Administration; but it is also necessary to affirm that the Railway Administration must do everything in its power to get this traffic back on the railway, or at least to guarantee the retention of the essential traffic. The means to be used for this purpose are those already indicated by the Administrations themselves in Part IV : abandoning useless traffic, active defence of essential traffic, in particular thanks to their road activities and a well advised commercial policy.

SUMMARIES.

It is not easy to draw any summaries from the long report we have drawn up, especially in view of the complex situation that the replies have brought to light.

According to the aims of the questionnaire, we will say first of all that the light railways, in spite of their different constructional characteristics, have essential functions to carry out similar to those of the main lines in the little developed countries mainly of Central Africa. On the other hand, they only have a secondary function to fulfil in European countries, and many of them are on their way to a slow decline; some of them, however, are still assuring irreplaceable tasks, and often fulfil an invaluable function, for the great national railways, which is not always recognised.

Today, these railways are the front line on which is taking place the great battle between rail and road; in order to survive, they are progressively carrying out profound structural reforms, which are making their operating methods more and more unlike those of the main line railways, and which is making it necessary to distinguish between the management of small and large railways. On the other hand it may be stated that this tendency towards an administrative severing between the secondary and main lines even inside the national systems, is one of the principal results of the study of our questionnaire.

Economic exigencies are in particular at the root of the definite preference there is today for diesel traction compared with electric traction.

Finally the sad fact that part of the secondary railway system must be abandoned by substituting road services for the railway services has led Railway Administrations to take to the roads and fight their opponents with their own arms : hence, on the one hand, the formation of combined motor-railway organisations, in which the small secondary railways have the advantage, and on the other hand, the creation of a road enterprise for the defence and if possible to recovery of the traffic of the main line railways.

This is all that the Railway Administrations can do; it is now for the Governments to remember that the important capital investments in railway installations over more than a century demand high utilisation and should not be compromised by a road policy which is often insufficiently thought out.

ADDENDUM.

After the drafting of this report, the Reporter has received the replies from the following Railway Administrations :

— *Viet-Nam Railways;*
— *Portuguese Railways;*
— *Finnish State Railways,*

as well as some statistical and economic information from the *Mozambique Railways.*

We sum up hereafter the principal data of these answers :

— The *Viet-Nam Railways* (the main characteristics of which are given in the Tables of the report) may be classified

in group *a*) although the predominance of traffic has changed between 1954 and 1956, from goods to passenger traffic. The balance sheet shows a deficit for the system as a whole, but the change-over to Diesel traction in the very near future is expected to bring important savings and improvement of the services.

It is to be noted that the average proceeds (18.8 Swiss centimes per ton/km, 4.4 per passenger/km) are comparable to those of the other railways of group *a*).

On the Viet-Nam system, the road competition is stronger than on the African lines; the reduction of traffic, for the part of the system considered as secondary (395 km), is estimated to be 50 %.

Co-ordination programs are not applied, apart from the scheme of road reconstruction, which gives preference to the roads connecting to the railway lines. The Railway Administration defends the freight traffic by means of motor delivery services through contractors, who arrange the collection and delivery of parcels traffic.

— The *Portuguese Railways Company*, although run by a private undertaking, comes into category *c*); it operates a system of 3 589 km in all, 1 176 km of which [408 km broad gauge (1.665 m) and 768 km (metre gauge)] are considered as light railways.

During the last 20 years, 86 km of lines have been built; no new sections are under project, but neither have any sections been replaced or abandoned.

At the present time, the lines are operated with a combination of steam and diesel traction. The traffic system adopted is that with a regulator and simplified system of signalling.

No exact economic information is available concerning the receipts, in particular the receipts per km; as regards costs, the following figures have been quoted :

broad gauge lines : S km = 11.9 + 25.6 = 41.5 (10^3 Swiss francs) ;

narrow gauge lines : S km = 9.3 + 20.3 = 29.6 (10^3 Swiss francs),

which are therefore comparable to those of the last group of lines in Table IV.

At the present time, the entire system is suffering from an operating deficit and a general rationalisation programme has been prepared, based above all on the suppression of steam traction, thanks to the electrification (with mixed 50 Hz and 3 000 V current) of the main line from Lisbon to Oporto and its branch line, and the generalisation of diesel traction over the rest of the system, in particular on the secondary lines which are the subject of this reply.

The rationalisation programme is bound up with the industrialisation programme of the country, both as regards the expected increase in traffic and the production of electric power.

It is not proposed to replace the railway services by road services; it is even considered that it would be advisable to complete the present system which has certain gaps at some points.

There is appreciable competition from motor transport, but it is less serious than in other countries; it should be noted that the Company has a considerable interest in road transport, both passenger (operated directly or by contract with private firms) and freight through its door-to-door services by means of a « General Transport Undertaking » the majority of the shares of which are held by the Company, or again by delivery services on contract.

The technical method used for such door-to-door services is the container; these often belong to the clients themselves; it should be noted moreover that the General Transport Undertaking and the hauliers under contract to the railway also act as intermediate agents between clients and the company; this all goes to show that the Portuguese Railways are taking full advantage of the greater liberty they enjoy as a private company.

— The *Finnish State Railways* operate a system of 5 071 km (1.524 m gauge), about half of which can be considered as a light railway on account of the

traffic. The whole system is operated by steam traction, and there are no up-to-date signalling and shunting installations. However, on the secondary lines, there are some railcar services, and the progressive change-over to diesel traction is beginning, as well as the making of safety installations; naturally, these measures will be applied on the main lines first of all.

One characterictic of the Finnish lines is the great variation in traffic in summer and winter, due to the closing down of the northern ports during the winter.

Although the reply did not include any statistical nor economic data, it should be noted that the Finnish Railways have already put in hand measures intended to simplify the operating, closing down or altering the status of certain poorly used stations, but above all by the *partial* replacement of railway services by road services, especially in the case of local passenger services and the delivery of parcels; because of these measures, the Finnish Railways now operate, either directly or through a special undertaking, a very extensive motor transport network, the services of which are considered as an integral part of the railway services, even from the tariff point of view.

On the other hand, the reply did not mention any lines totally replaced by road services, except on a few sections already operated by private companies.

— The statistical results of the *Mozambique Railways* mentioned in the report, are distinguished by average proceeds (unless mistakenly evaluated in the conversion of the currency) and also by extremely low rates (6 Swiss centimes per ton/km); with regard to the expenditures, it is not possible to supply total data, it is only noted that the operating expenses are predominant, the obvious characteristic of steam traction.

625 .285]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

17th. SESSION (MADRID 1958).

QUESTION 3.

Design and improvement of railcars and multiple-unit diesel trains, as regards :

— traction power equipment (location and suspension of the engine, type of transmission);

— characteristics of the construction (body and bogies);

— weight reduction;

— sound-proofing, heating, ventilation, air conditioning (supply of power required, advantages and drawbacks);

— buffer and traction gear. Intercommunication.

SUPPLEMENT TO REPORT (*)

by A. S. Canavezes Jr.,

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After we had completed our report, we received replies to the questionnaire from the 3 following Administrations :

— Spanish National Railways (R.E.N.F.E.);
— Turkish State Railways (T.C.D.D.);
— Greek State Railways (C.E.H.)

as well as additional information from :

— The Finnish State Railways.

The present supplement has been drawn up in order to take these replies and additional information into consideration. It should be noted that the Finnish State Railways had already sent in a reply which we took into account in our Report. This was, however, an incomplete reply in which the data concerning the type Dm 4 railways of this Administration were not included. It was these data which, completing their reply, arrived after we had concluded our Report.

Like the Report, this supplement is div-

(*) See « Bulletin » for April 1958, p. 499.

ADMINISTRATION	*Turkish State Railways*			
	Standard and wide gauge lines			Narrow gauge lines
	main	secondary	total	
Length of lines in km				109
— single track	7 558	—	7 558	—
— multiple track	64	—	64	—
Total	7 622	—	7 622	109
Gauge in mm	—	—	1 435	1 000
Admissible axle load, in t	—	—	13.5-20	—
Length of lines worked with Diesel railcars and trains in km	S.G. = 3 636.5			
Total number of trains-km in 1956	33 709 591			
— of which, total passenger service	10 645 926			
— of which, Diesel railcars and trains	—			
— of which, Diesel railcars	2 929 057			
Total number of tkm in 1956	15 924 514 592			
— of which, total passenger service	2 949 785 078			
— of which, Diesel railcars and trains	—			
— of which, Diesel railcars	320 938 183			
Total consumption of fuel oil in 1956 used for operating on railway lines in t/year	—			
— of which, for railcars	6 579			
Percentage of fuel oil consumption for railcars compared with total consumption on the railways	—			
Price of a ton of fuel oil in U.S. dollars	100			
Total number of vehicles with Diesel engines (locomotives and railcars)	97	—	97	—
— of which railcars	53	—	53	—
average number of railcars available (in service and spare), %	66	—	66	—
average number of railcars in service, %	44	—	44	—
average numb. of railc. undergoing running mainten., %	26	—	26	—
average number of railcars undergoing repairs (in shops), %	30	—	30	—
Average daily mileage of railcars, in km	—	—	320	—

* The equivalence of these figures shows that no Diesel locomotive was in use in 1956.

** For all the railca

Spanish State Railways				*Hellenic State Railways*				
Standard and wide gauge lines			Narrow gauge lines	Standard and wide gauge lines			Narrow gauge lines	
main	secondary	total		main	secondary	total		
5 865	5 286	11 151	—	1 516	365	1 881	202	29
1 846	—	1 846	—	—	—	—	35	1
7 711	5 286	12 997	—	1 516	365	1 881	237	30
—	—	1 674	—	—	—	1 435	1 000	600
—	—	14-22	—	—	—	14-16-20	11	
10 590				S.G. = 1 516			N.G. = 202	
101 466 176				9 666 683				
50 231 852				6 672 279				
7 652 621				2 957 660 *				
3 887 901				2 957 660 *				
34 431 060 900				2 022 710 975				
11 226 136 000				1 185 207 216				
721 405 000				198 346 177 *				
589 162 400				198 346 177 *				
~ 12 239 033				2 022.5 *				
~ 1 532 460				2 022.5 *				
12.5				—				
138.39				82.23				
116	18	134	—	27	—	27	14	
96	18	114	—	25	—	25	14	
—	—	80	—	82	—	82	76	
—	—	75	—	82	—	82	64	
—	—	5	—	9	—	9	12	
—	—	15	—	9	—	9	12	
300	200	—	—	—	—	7 700 **	2 700 **	

ided into the 3 following parts, though naturally in much shorter form :

I. **Introduction.**
   A) Analysis of the information received from the participating Administrations;
   B) Numerical data of a general nature relative to the Railways and use of Diesel traction;
   C) Detailed information concerning railcars.

II. **Ideas and opinions of the Administrations concerning the design and improvement of railcars.**
   A) Object of using railcars;
   B) Standardisation of railcars;
   C) Improvement of railcars :
      1) Motor equipment (engine, transmission and drive);
      2) Body, bogies and their suspension;
      3) Weight reduction;
      4) Sound proofing;
      5) Heating, ventilation and air conditioning;
      6) Buffing and traction gear. — Intercommunication.
   D) Cost of operating railcars.

III. **Summaries.**

I. INTRODUCTION.

A. Analysis of the information received from these 4 Administrations.

To make what follows clear, we would remind readers that in the questionnaire information was requested :

in the *first part,* of a general nature concerning the system and the use of Diesel traction;

in the *second part,* details concerning the railcars built between the 1st January 1946 and 1st January 1957, under construction, or being designed;

in the *third part,* concerning the ideas and opinions of the Administrations on the subject of the design and improvement of railcars.

However, two of these four Administrations only gave in their replies information concerning 2 of the 3 parts of the questionnaire. In fact, the replies received relate :

— in the case of the Spanish National Railways and the Hellenic State Railways to the 3 parts of the questionnaire;

— in the case of the Turkish State Railways, to the first and third parts;

— in the case of the Finnish State Railways, to the first and second parts.

As far as the reply from the last named Administration is concerned, it is only necessary to deal in this supplement (under I-C) with the additional data subsequently supplied for the type Dm 4 railcars, as all the other information received has already been considered in the report as stated.

B. Numerical data of a general nature relative to the railways and the use of Diesel traction.

These data, which include the essential characteristics of the railway systems and information concerning the use of Diesel locomotives and railcars have been collected together in Table I. They relate to the Spanish National Railways (R.E.N.F.E.), Turkish State Railways (T.C.D.D.) and to the Hellenic State Railways (C.E.H.).

C. Detailed information concerning the Diesel railcars built between the 1st January 1946 and the 1st January 1957, under construction or being designed.

The R.E.N.F.E. states that between the 1st January 1946 and 1st January 1957, they have acquired the following Diesel railcars :

in 1949 : 10 Renault 8 wheeled railcars, 300 HP, type ABJ;

in 1950 : 2 Talgo trains, each consisting of a Diesel-electric locomotive and

16 trailers of different types with air conditioning, and one spare locomotive;

in 1952: 20 TAF rakes (15 of which have air conditioning), each rake consisting of 2 motor units and an intermediate trailer;

in 1954: 10 TAF type 8 wheeled railcars, without air conditioning, which can be coupled together to make up TAF trains;

in 1954: 1 Ferrobus train consisting of a motor unit with 4 wheels (two 150 HP engines) and two four wheeled trailers;

in 1956: 10 Renault 8 wheeled railcars, 300 HP, type ABJ.

However this Administration points out that:

a) the Renault railcars were built in France by the « Régie Nationale des Usines », and their characteristics are altogether identical with those of the similar S.N.C.F. stock;

b) the Talgo trains really do not come into the railcar class;

c) except for a slight difference in appearance, the 10 TAF type railcars are similar to the TAF rakes (no difference as regards their power, auxiliary equipment, transmission, number of seats, etc.);

d) the Ferrobus train is the same as those of the German Railways built by the Uerdingen Waggonfabrik at Krefeld.

Consequently, the detailed information supplied by the R.E.N.F.E. concerning its railcars only relates to the TAF rakes, which were built by the Fiat Company of Turin (body and bogies) and the O.M. Company of Brescia (engines).

These particulars, together with those supplied by the Hellenic State Railways (C.E.H.) and the Finnish State Railways concerning their type Dm 4 railcars, are given in Table II:

We might point out that the TAF rakes are identical in construction with those of the triple My 501/506 rakes of the Portuguese Railways described in the Report (see Table 4 *b* and fig. 23, 26 and 27). We will therefore not give any other details about these rakes.

As regards the type Dm 4 railcars of the Finnish State Railways (fig. 1), we give below the following details to complete those given in Table II:

Engines:

— 2 × 350 HP — 1 engine on each bogie (see Table III).

Transmission:

— hydromechanical — 5 speeds — installed on the bogies.

Connection between the engine and the transmission:

— flexible shaft — hydro-dynamic coupling.

Driving of the motor axles:

— individual drive — cylindrical sets of gears — no differential.

Framework of body:

— mixed steel-light alloy construction — use of rolled sections — assembled by rivetting and welding.

Soundproofing of body:

— against running noises and the noise of the engines (1 layer of Isoflex 40 mm thick).

Primary suspension:

— leaf springs and rubber springs (without shock absorbers).

Secondary suspension:

— coiled springs (with shock absorbers).

Owner Administration :	Unit	*Finnish State Railways*
Designation of type		Dm 4 (1 Ao) + (Ao 1)
Normal composition of the rake		1 motor unit + 3 trailers
Type of intercommunication		gangway with bellows
Maximum permissible speed	km/h	110
Installed power per railcar (each motor unit)	H.P.	2 × 350
Number of vehicles of this type :		
a) Motor units		23
b) Trailers		18
c) Trailers with driving compartment		—
Proposed constructional programme for this type in the future		No
Main use		on main lines in passenger traffic in express long distance services in express services
Number of seats 1st/2nd class :		
a) Motor unit		2nd class : 48
b) Trailer		1st trailer — 1st class : 35 2nd trailer — 2nd class : 56 3nd trailer — 2nd class : 62
c) Trailers with driving compartment		—
Area of luggage compartment	m^2	—
Additional space available for special usages	m^2	Restaur. and bar: 8.1
Weight empty :		
a) of the motor unit	t	47.3
b) of the trailer	t	100.3
c) of the trailer with driving compartment	t	—
Radius of action of a standard unit	km	about 800
Power installed/Weight of the rake	HP/t	4.7
Residual acceleration on the level when running at the maximum speed	$m\ sec^2$	—
Maximum speed up gradients of 10 ‰	km/h	—
Maximum speed up gradients of 25 ‰	km/h	—
Average annual mileage per vehicle	km	105 000
Average mileage in service between :		
— 2 intermediate overhauls	km	—
— 2 general overhauls	km	140 000
Average mileage in service between 2 breakdowns	km	—
Percentage of average annual cost for maintenance and repairs in relation to purchase price :		
— for a motor unit	%	3.6 *
— for a trailer	%	1.5 *
— for a trailer with driving compartment	%	—

* For maintenance and repair costs in the shops.

services.

Spanish State Railways	*Hellenic State Railways*	
TAF rakes	FIAT 077 B	RENAULT ABJ 9
otor unit + 1 trailer with driving comp. + 1 motor unit	1 motor unit + 1 trailer + 1 motor unit	1 motor unit + 1 ord. coach
gangway with bellows	gangway with bellows	without gangway
120	95	88 and 60 (with ord. coach)
505	2 × 225	300
40	15	8
—	8	—
20	—	—
No	Yes	No
on main lines in passenger traffic in express long distance services in other fast services	on main lines in passenger traffic in express long distance services in fast services	on main lines in passenger traffic in express long distances services in fast services
2nd class : 64 (each motor unit)	1st class — 24 2nd class — 48 + 10** = 58	2nd class — 64 + 6** = 70
—	1st class — 24 2nd class — 62 + 12** = 74	2nd class 35 (ord. carriage)
2e class : 46	—	—
10	3	8.50
Bar : 25.5	Rest. and bar : 4.3 — Mail : 1.1	Rest. and bar : 2.2 — Mail : 2.6
55	41	31
—	28	—
43	—	—
1 500	about 1 400	about 350
6.6	8.1	9.6
—	0.08	—
80	—	—
45	45	35
120 000	120 000	110 000
100 000	150 000	—
200 000	250 000	220 000
231 000	—	—
8	—	—
—	—	—
2	—	—

** Flap-seats

TABLE II. — **Railcars for fast services** *(continued.)*

Owner Administration :		*Hellenic State Railways*
	Unit	
Designation of type		BREDA Aln 669 T
Normal composition of the rake		1 motor unit ***
Type of intercommunication		gangway without bellows
Maximum permissible speed	km/h	72
Installed power per railcar (each motor unit)	H.P.	2 × 195
Number of vehicles of this type :		
a) Motor units		14
b) Trailers		—
c) Trailers with driving compartment		—
Proposed constructional programme for this type in the future		No
Main use		on secondary lines in passenger traffic in express long distance services in fast services
Number of seats 1st/2nd class :		
a) Motor unit		2nd class — 69 + 3** = 72
b) Trailer		—
c) Trailers with driving compartment		—
Area of luggage compartment	m^2	1
Additional space available for special usages	m^2	Restaur. and bar : 2
Weight empty :		
a) of the motor unit	t	35
b) of the trailer	t	—
c) of the trailer with driving compartment	t	—
Radius of action of a standard unit	km	1 200
Power installed/Weight of the rake	HP/t	11.1
Residual acceleration on the level when running at the maximum speed	m/sec^2	—
Maximum speed up gradients of 10 ‰	km/h	—
Maximum speed up gradients of 25 ‰	km/h	30
Average annual mileage per vehicle	km	66 000
Average mileage in service between :		
— 2 intermediate overhauls	km	20 000
— 2 general overhauls	km	60 000
Average mileage in service between 2 breakdowns	km	—
Percentage of average annual cost for maintenance and repairs in relation to purchase price :		
— for a motor unit	%	—
— for a trailer	%	—
— for a trailer with driving compartment	%	—

** Flap-seats

*** May be coupled with similar units.

Heating :

— steam and hot air — each vehicle heated separately (the engine cooling water is mainly used to heat the motor unit);

— manual control by the train staff.

Ventilation :

— the upper part of the windows can be opened;

— blower fans along the ceiling (evacuation of used air under the seats);

— air completely renewed thirty times an hour.



Fig. 1. — Dm 4 railcar of the Finnish State Railways.

II. IDEAS AND OPINIONS OF THE ADMINISTRATIONS CONCERNING THE DESIGN AND IMPROVEMENT OF RAILCARS.

A. Object of using railcars.

According to the information supplied by the R.E.N.F.E., T.C.D.D. and C.E.H., the use of railcars is dictated by reasons of economy, flexibility of working, rapidity and the comfort of passengers. The R.E.N.F.E. also stresses as an argument in favour of using railcars, the longer daily runs which can be obtained with these vehicles, resulting in a considerable reduction in amortization periods, which facilitates the modernisation and replacement of the stock within a short period; and, on the other hand, that the railcar owing to its low weight per axle, can run on all the lines of the system, and has less effect upon the maintenance of the permanent way.

In the case of momentary traffic peaks, the R.E.N.F.E. is of the opinion that it is more economical to use a heavy rake hauled by a Diesel locomotive rather than to multiply the number of railcar services.

The T.C.D.D. states that as far as it is concerned momentary traffic peaks are dealt with by coupling up rakes together.

It will be noted that both these Administrations are of the opinion that in such a case, it is advisable to avoid multiplying the number of railcar runs and meet temporary traffic peaks either by replacing the railcars by an ordinary train hauled by a Diesel locomotive, or by increasing the size of the Diesel rakes, according to the amount of traffic and other circumstances.

With regard to the C.E.H., they prefer to multiply the number of railcar runs in such circumstances.

As regards the use of large capacity railcars run as multiple units with trailers, the R.E.N.F.E. is of the opinion that such a use should be extended to all the short and average distance stopping services on the main lines and to all the regional services. This Administration also considers railcars are suitable for express services and for luxury long distance services on the main lines. It considers that the services using such stock have the advantage of lower operating costs.

The T.C.D.D. expresses a similar point of view.

B. Standardisation of railcars.

Standardisation of the types of railcars used for the various services, as well as their engines and transmissions, is under consideration for the future by the R.E.N.F.E. and T.C.D.D., and studies are

TABLE 3. — **Types of engi**

Owner Administration :	*Finnish State Railways* (railcar Dm 4)
Type	12 cylinder with direct injection engine (type n° 12.103)
Maker	General Motors Corporation, U.S.A.
Nominal power in HP	350 HP (at 1 800 r.p.m.)
2 stroke / 4 stroke Horizontal / vertical / in V	2 stroke —
Average speed of the piston at nominal speed in m/sec	7.6
System of supercharging	—
Supercharge air pressure at full load in kg/cm^2	—
Increase in the power compared with non-supercharged engine in %	—
System of cooling the engine	By water
System of dissipating the heat in the engine lubricating oil	By the engine cooling water (heat exchanger)
Weight of diesel engine (without lubricating oil) in kg	2 000 (equipment included)
Ratio $\frac{\text{weight}}{\text{HP}}$ in kg	5.7
Temperature of exhaust gases at full load and nominal speed : — at the collar of the exhaust collector	—
— at the entry to the turbo-compressor	—
Lubrication by lubricating oil with additions or without additions	With additions
Viscosity in SAE at 20 %	in Summer : 30 in Winter : 20
Special safety devices : against corrosion, cavitation against erosion against excess speed against insufficient oil pressure against insufficient water reserve against excessive water temperature against too low water temperature on starting	— — Speed regulator Pressure gauge and luminous control Level indicator Thermometer Preheating by « Fluid heat » device fitted to the cooling system of the engines
Principle or regulation	—
Filters on the engine for	Air : 1 — Lubricating oil : 4 — Fuel : 4

In the ABJ 9 Renault Diesel railcars of the C.E.H., the Renault

in Diesel railcars.

Hellenic State Railways	
(Fiat 077 B)	(Breda Aln 669 T)
Fiat 700.110	Breda D. 20
Fiat	Breda
225 HP (at 1 500 r.p.m.)	195 HP (at 1 600 r.p.m.)
4 stroke	4 stroke
—	—
9.8	10.1
—	—
—	—
—	—
By water	By water
By water	By water
1 990 ± 2 %	—
8.8	—
680° C	—
—	—
With additions	With additions
40	—
Addition of anti-corrosive Nalco 38 product Centrifugal regulator on the feeding pump Injection electromo-magnet regulator Float level stopping the engine Thermostat stopping the engine Preheating of the water by means of a boiler	Addition of anti-corrosive product Centrifugal regulator on the feeding pump Light signal in the driving compt. Float level stopping the engine Thermostats putting the fans into action Preheating of the water by means of electric resistance
Combined regulation of the speed and the feed	—
Air : 1 — Lubricating oil : 5 — Fuel-oil : 3	Air : 2 — Fuel-oil : 1

517 J engine is used; same was described in Table 5 of the Report (page 576/136).

now being made in this connection. The C.E.H. consider also such standardisation as far as it does not increase the difficulty of acquiring railcars.

C. Improvement of railcars.

1. *Motor equipment.*

Choice of the number of engines. — The R.E.N.F.E. does not consider it is economic to equip a railcar with 2 engines of lower power rather than with 1 engine. This Administration only uses the solution of 2 engines in cases where safe running makes it desirable and the power required per rake exceeds 1 000 HP.

The T.C.D.D. and C.E.H., in certain cases, also stipulate the solution of 2 engines.

Choice of type of engine. — The 3 Administrations in question prefer to use 4 stroke rather than 2 stroke engines on their railcars.

The R.E.N.F.E. states that they prefer engines whose speed does not exceed 1 500 r.p.m. and that in their opinion the 4 stroke engine is simpler in working than the 2 stroke.

Siting and suspension of the engine. — Neither of the 3 Administrations expressed any definite preference for the various arrangements generally adopted for the installation of the engine. They stressed the advantages and drawbacks of putting the engine on the bogie, in the body and under the floor, as we did in our report. The T.C.D.D. however considers that it is better to put the engine in the body or under the floor rather than on the bogie.

Treatment of the engine cooling water. — These 3 Railways use water that has been treated with Nalco 38 in the engine cooling circuits (the T.C.D.D. also une Nalco 39 as well as Nalco 38).

Choice of the method of transmission. — The T.C.D.D. for powers of 150 to 200 HP stipulates the use of hydromechanical transmissions, and hydraulic transmissions for higher powers of up to 1 000 HP.

According to the power to be transmitted, the R.E.N.F.E. considers that the choice of the system of transmission should be as follows :

— powers not exceeding 300 HP : mechanical transmissions;

— powers between 300 and 1 000 HP : hydro-mechanical transmissions;

— powers of more than 1 000 HP : electric transmission.

This Administration is of the opinion that if the various types of transmission are compared, from the points of view of weight, convenience of drive, output, size, regularity of working, purchase price, maintenance and repair costs, respectively — their relative advantages put them in the order of preference shown in the table on the following page.

Replacement of the transmission (non-electric). — In the case of non-electric transmissions, the T.C.D.D. lays down that the transmission shall be put on the bogies.

The R.E.N.F.E. however states that it should be put under the body if the maximum floor space is to be made available for the use of passengers. If not, the transmission can be fitted in the body (with the advantages of being completely accessible) or on the bogie.

Driving of motor axles. — The R.E.N.F.E. and the T.C.D.D. stipulate for this purpose the use of straight sets of gears.

Driving compartments. — The R.E.N.F.E. prefers to have a driving compartment at each end for all the services, one as the main driving compartment and the other as the auxiliary one.

Electric transmission : suspension of traction motors. — In this connection, the R.E.N.F.E. considers that nose suspension with rigid gears is sufficient.

From the point of view of :	*Order of preference of the transmissions* :			
	1	2	3	4
Weight	mechanical	hydromechanical	hydraulic	electric
Driving convenience	electric	hydromechanical	hydraulic	mechanical
Output	mechanical	hydromechanical	hydraulic	electric
Size	electric	mechanical	hydromechanical	hydraulic
Regularity of working	electric	hydromechanical	mechanical	hydraulic
Cost price	mechanical	hydraulic	hydromechanical	electric
Maintenance and repair costs .	mechanical	electric	hydromechanical	hydraulic

2. *Body, bogies and their suspension.*

Construction of body and bogies. — The R.E.N.F.E. stipulates welded construction for the body with the use of light metals, and for the bogies, cast steel construction (in 1 piece). In cases where such a type of construction for the bogies is not possible. this Administration recommends a welded construction with the use of rolled sections.

The T.C.D.D. in general stipulates welded construction.

Suspension of the body and bogies. — The R.E.N.F.E. prefers for these suspensions the use of coiled springs in conjunction with rubber springs and hydraulic shock absorbers.

The T.C.D.D. for the suspension of the bogies stipulates leaf springs and coiled springs for the suspension of the body.

3. *Weight reduction.*

The T.C.D.D. states that they are not in a position to reply to the questions concerning weight reduction.

Ratio « power installed/weight to be moved ». — The R.E.N.F.E. considers that to reach high speeds a power of 7 HP per ton is sufficient on lines with gradients of up to 10 mm/m, but they state that a minimum of 10 HP per ton must be allowed on lines with gradients of up to 20 mm/m.

Object in view in weight reduction. — The R.E.N.F.E. states that the object in view in light weight construction is to obtain without reduction of the power installed an increase in the useful life of railcars, better performances, and a reduction in operating and maintenance costs.

This Administration recognises that weight reduction leads to a longer life of the running gear and a very considerable increase in the mileage worked between successive retreadings of the tyres.

Constructional ideas. — The R.E.N.F.E. is of the opinion that weight reduction should cover the body in particular. It considers the trailers of the *Talgo* train as being of extra light weight construction, whilst the Renault railcars, *Taf* trains and *Ferrobus* are of light weight construction.

For the extra light weight construction (Talgo type), this Railway states that the frame and body must be made of high strength aluminium sections and sheets (with manganese, silicon and copper), the structure of the body being of the tubular type.

In the case of other so-called light types of construction, the frame should be of steel and the body of high strength aluminium, the whole again forming a tubular structure. The Spanish Railways do not propose to go further in weight reduction than they have done with the *Talgo* trains.

4. *Sound insulation.*

The R.E.N.F.E. is of the opinion that sound insulation should be used on all railcars used for average and long distance runs, even when they do not come into the luxury class.

The T.C.D.D. considers there is no point in sound insulation in the case of small railcars, but that it is advisable for the railcars used for long distance services.

Both Administrations stated they were not in a position to supply any data concerning the noise levels to be recommended inside railcars. In the opinion of the R.E.N.F.E., the use of felt sheets in conjunction with glass wool is to be recommended as a method of sound insulation.

As regards reducing the noise produced by the engine equipment in its vicinity, this Railway stipulates siting the exhaust outlets above the roof of the railcars and the fitting of silencers.

5. *Heating, ventilation and air conditioning.*

Systems of heating and ventilation. — In the case of railcars which are not equipped with air conditioning, the R.E.N.F.E. stipulates either heating by aerotherms with which the air is heated by the exhaust gases, or heating by electric radiators.

This Administration recognises however, that the former system has the drawback in cold weather of insufficient output until the engine has been running for some time.

In the opinion of the R.E.N.F.E., hot water heating means having too complicated an installation (boiler, pipes, etc.) for this type of stock.

The T.C.D.D. for its part prefers in general hot air heating for small railcars and hot water heating for large railcars.

As far as ventilation is concerned, the R.E.N.F.E. stipulates the use of fixed ventilators in the roofs or ventilators under the passenger compartments.

Air conditioning. — The R.E.N.F.E. considers that air conditioning is advisable on all the long distance railcars and Diesel rakes, especially in the case of the luxury services.

This railway lays down in winter, with an outside temperature below — 15° C., the temperature inside the railcars should be + 23° C., and in summer with an outside temperature of + 45° C., the temperature inside the railcars should not exceed 20° C.

These conditions must be fulfilled under the most difficult conditions, even at speeds of 140 km/h.

On the other hand, the difference in temperature at floor and ceiling levels must never exceed 2° C.

The air conditioning system preferred by the R.E.N.F.E. is that of the firm of Stone & Carrier.

In the opinion of this Administration, the installation of air conditioning increases the weight of the railcars by 10 % and their cost by 12 %.

The T.C.D.D. is of the opinion that the use of air conditioning is only necessary in the case of long distance railcars.

6. *Buffing and drawgear. Inter-communications.*

Buffing and drawgear. — In the opinion of the R.E.N.F.E., railcars should be fitted with a light type of automatic coupling.

The various connections (pneumatic, electric, etc.) must all be combined in this one coupling which should also include an additional part enabling a standard railway coach to be coupled up if necessary. In addition, each railcar should have rubber or metal buffers at each end, of sufficient elasticity to support shocks without damaging the structure of the vehicle. These buffers must therefore be carried on components of sufficient strength.

Inter-communications. — In addition to the intercommunications to be included in the automatic coupling mentioned above, the R.E.N.F.E. also provides a passage and bellows with a minimum width of a metre to allow passengers to pass from one vehicle to another.

D. Operating costs of railcars.

On the basis of the information supplied by the 3 Administrations, we have given in the following table the cost per 1 000 axle km for railcar services (in the national currency and in U.S.A. dollars), as well as the division of these costs into percentages under the following headings : sinking fund, fuel, labour, maintenance and repairs :

Administration	*Cost per 1 000 axle/km*			*Percentage of cost for*			
	in national currency		in U.S.A. dollars	Fuel	Labour	Maintenance and repairs	Sinking-fund
C.E.H.	Drachmae	1 916	63.87	16.82	26.28	5.70	51.20
R.E.N.F.E. :							
TALGO train (16 axles) * . .	pesetas	3 237	77	20	30	25	25
RENAULT railcar (4 axles) ** . . .	»	3 108.5	74	20	25	15	40
TAF rakes (12 axles) *** . .	»	4 942	117.5	17	35	24	24
T.C.D.D.	—	—	—	17.2	7.8	49.8	25.2

* Train consisting of an 8 wheeled Diesel-electric locomotive and 12 two-wheeled trailers (total weight of the train loaded : 122.5 tons).

** Weight of each railcar : 39 tons loaded.

*** Rake consisting of 2 motor units and 1 trailer, all with 8 wheels (weight of rake loaded : 174 tons).

The R.E.N.F.E. considers that the above costs could be reduced by adopting the principles of construction for railcars indicated above.

In their opinion, the reduction would be 25 % in the case of the sinking fund costs, 15 % in the case of labour costs, and 20 % in the case of maintenance costs.

The T.C.D.D. considers that savings could be made on maintenance and repairs.

III. CONCLUSIONS.

It can be stated that in general the ideas and opinions of the R.E.N.F.E., T.C.D.D. and C.E.H., which we have just quoted concerning the various aspects of this question agree with those given in the Report. If in certain cases (too rarely), the views of one or other of these Administrations are not absolutely identical with those of the majority of the Administrations, they closely resemble the particular views of other Railways, which we also included in our Report.

Under these conditions, in our opinion, there is nothing to be added to the conclusions on account of the information given in this present supplement, so that the general conclusions of the Report as expressing the tendencies of the Railways remain valid.

Oporto, April 1958.

ERRATA.

Report on Question 3, 17th Session (Madrid, 1958),

by A. S. CANAVEZES Jr., appearing in the I. R. C. A. Bulletin for April 1958.

	TABLE 3. — General information			
	Page 504/63 : *Austrian Federal Railways*		Page 511/70 : *Yugoslavia Railways*	
	instead of :	*read* :	*instead of* :	*read* :
Total number of t/km in 1956 . .	24 131 000	24 131 000 000	32 813 048	32 813 048 000
of which :				
total passenger service. . . .	7 390 000	7 390 000 000	7 897 964	7 897 964 000
Diesel railcars and trains . .	768 300	768 300 000	—	—
Diesel railcars	496 900	496 900 000	71 835	71 835 000

REMARK.

Taking into account the information supplied concerning the number of vehicles with Diesel engines used by the Administrations considered in the Report and in the present Supplement — 21 Administrations representing together a total mileage of about 147 600 km of lines — it is necessary to make the following rectifications :

a) the total number of vehicles with Diesel engines (locomotives and railcars) used on all the Railway systems considered amounts to 5 290;

b) the total number of railcars also used on all the Railway systems considered amounts to 2 908.

[621 .335]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

17th. SESSION (MADRID, 1958).

QUESTION 4.

Comparative study of the periodical maintenance and repair of electric locomotives, in particular as regards :

- **the wear of the tyres (influence of the wheel diameter, the axle-load, the speed, the type of bogies and eventually undulatory wear of the rails, etc.);**
- **the maintenance of traction motors and their transmission (flash at the collectors and methods of coping with it, use of roller bearings for the suspension of the motors and the hollow shafts, etc.);**
- **lubricants used (classical and such new types as bisulphide of molybdenum);**
- **wear of the friction strips of the pantographs.**
- **Kind of work and periodicity.**
- **Organisation of the maintenance and influence of common user (banalisation) of the locomotives.**
- **Prime cost in relation to the type of equipment and the age of the engines.**

SUPPLEMENT TO REPORT,(*)

by K. J. Cook,

Chief Mechanical & Electrical Engineer, Eastern & North Eastern Regions, British Railways, Doncaster.

In order to complete the record of the information received from the various administrations the following tables are published as a supplement to my report which appears in Vol. XXXV, No. 3 (March 1958) of the *Bulletin of the International Railway Congress Association.*

The information respecting Poland properly belongs to Mr. Viani's report, but on account of late arrival is being incorporated in this supplement.

(*) See « Bulletin » for March 1958, p. 219.

TAB

No.	Country	Administration	System
16	POLAND	Polish State Railways	3 000 V. D.C.
17	SOUTH AFRICA	South African Railways & Harbours	3 000 V. D.C.
18	JAPAN	Japanese National Railways	1 500 V. D.C. 750 V. D.C. 600 V. D.C. 600 V. D.C. 20 000 (50 cycles) A.C.
19	U.S.A.	Pennsylvania Railroad	11 000 V. 25 cycle single phase
20	SWEDEN	Swedish State Railways	1 500 V. 16.2/3 Hy single phase
21	SWEDEN	Stockholm Roslagens Jarnvager	1 500 V. D.C.
22	UNITED KINGDOM	London Transport	600 V. D.C.
23	UNITED KINGDOM	British Railways (M.S.W. only)	1 500 V. D.C.
24	INDIA	Indian Government Railways	1 500 V. D.C.

Contact line	*Electrified lines mileages*		*Electrified lines*	
	Single track km	*Double track km*	*Main lines km*	*Other lines km*
		486		
Catenary	2 900 including multiple track	690		
Catenary » » Third Rail Catenary	970	991	1 077	884
Catenary			1 068	2 517
Catenary	5 384	941	4 395	989
Catenary	107	12	106	1
Fourth Rail	314	354		
Catenary		109	219	264
Catenary	6	291	768	177

TABLE 3.

No.	*Country*	*Administration*	
16	*POLAND*	*Polish State Railways*	Compressed Air - electric brakes not used in any form.
17	*SOUTH AFRICA*	*South African Railways and Harbours*	Regenerative on 1E, 2E and 4E.
18	*JAPAN*	*Japanese National Railways*	Regenerative on ED 42, EF 16.
19	*U.S.A.*	*Pennsylvania Railroad*	—
20	*SWEDEN*	*Swedish State Railways*	—
21	*SWEDEN*	*Stockholm Roslagens Jarnvager*	—
22	*UNITED KINGDOM*	*London Transport*	—
23	*UNITED KINGDOM*	*British Railways*	Regenerative at higher speeds. Rheostatic at lower speeds.
24	*INDIA*	*Indian Government Railways*	Regenerative on heavy grades as auxiliary on EM 1 and EF 1.

TABLE 2. — General data concerning the various types of locomotives.

No.	Country	Administration	Type or series	No. of loco-motives	Average annual mileage km	Year of construction	Builder		Length over buffers m	Overall wheelbase m	Axle arrangement	Bogie Wheel-base m	Distance between bogie pivots m	Weight in running order		Weight per driving axle (metric tons)	Weight per carrying axle (metric tons)
							Mechanical part	Electrical part						Mech. Part (metric tons)	Elec. Part including transmission (metric tons)		
16	POLAND	Polish State Railways	E 01	—	—	1934	Chrzanow	M.V.	13.564	—	Bo Bo	—	6.477	43.7	31.5	18.8	—
			E 02	—	—	1953	Pafawag	M.V.	15.000	—	Bo Bo	—	7.450	49.5	31.5	20.25	—
			E 03	—	—	1951	ASEA	ASEA	14.170	—	Bo Bo	—	6.800	81.2 (total)		20.3	—
			E 04	—	—	1953	LEW	LEW	16.370	—	Bo Bo	—	7.800	49.5	40.5	21.5	—
			E 05	—	—	1954	LEW	LEW	18.500	—	Co Co	—	7.750	113.3 (total)		18.9	—
17	SOUTH AFRICA	South African Railways & Harbours	1 E	172	128 371	1925-1945	Swiss Loco. & Machine Wks. R.W. Hawthorne, England Werkspoor, Amsterdam Steph. & Hawthorne England	Met-Vick	13.310	9.423	Bo+Bo	2.819	6.604	54.9 (total)	—	17.48	—
			E S	22	82 765	1936-38-53	Werkspoor, Amsterdam	Met-Vick British Gen. Electric	13.310	9.423	Bo+Bo	2.819	6.604	52.8 (total)	—	17.02	—
			2 E	3	42 104	1940	Henschell, Germany	Siemens & Halske	13.310	9.423	Bo+Bo	2.819	6.604	52.8 (total)	—	17.02	—
			3 E	28	101 571	1947-1949	Steph. & Hawthorne, England	Met-Vick	17.196	12.802	Co+Co	4.267	9.144	86.4 (total)	—	18.59	—
			4 E	40	129 046	1952-1954	North British	British Gen. Electric	21.844	18.390	1 Co+Co 1	6.833	10.795	111.8 (total)	—	21.84	13.20
18	JAPAN	Japanese National Railways	EF 10	41	84 480	1934	Hi, Ki, Kr, Mh, Ni.	Hi, Kd, Me, Ts, Ty.	18.380 or 17.500	14.620	1 C+C 1	4.240	9.100	90.3 (total)	—	12.61	7.30
			EF 11	4	84 480	1934	Ki.	Ts.	18.380 or 17.500	14.620	1 C+C 1	4.240	9.100	88.6 (total)	—	12.41	7.08
			EF 12	17	84 480	1941	Hi, Ki, Mh, Ni.	Hi, Me, Ts, Ty.	17.500	14.620	1 C+C 1	4.240	9.100	90.3 (total)	—	12.61	7.30
			EF 13	31	84 480	1944	Kr, Mh, Hi, Ts.	Hi, Kd, Me, Ts.	17.500	14.620	1 C+C 1	4.240	9.100	89.8 (total)	—	12.79	6.53
			EF 15	113	119 360	1947	Hi, Ki, Kr, Mh, Ts.	Hi, Kd, Me, Ts, Ty.	17.000	14.500	1 C+C 1	4.220	9.000	72.5	29.1	12.97	7.35
			EF 16	12	71 520	1951	Hi, Kr.	Hi, Kd.	17.000	14.500	1 C+C 1	4.220	9.000	96.1 (total)	—	13.70	7.22
			EH 10	27	178 880	1954	Hi, Ki, Kr, Mh, Ts.	Hi, Kd, Me, Ts, Ty.	22.500	18.600	(B—B) — (B—B)	3.100	4.950	67.3	37.9	13.15	—
			EF 53	19	119 360	1932	Hi, Ki, Kr, Mh, Ni.	Hi, Kd, Me, Ts, Ty.	19.920	18.020	2 C ! C 2	4.240	9.100	89.7 (total)	—	11.09	5.79
			EF 55	3	119 360	1935	Hi, Kr, Ni.	Hi, Kd, Ty.	19.150	16.320	2 C+C 2	4.240	9.100	91.1 (total)	—	11.96	7.76
			EF 56	12	119 360	1937	Hi, Kr, Mh.	Hi, Kd, Me.	19.920	18.020	2 C+C 2	4.240	9.100	100.5 (total)	—	12.66	6.15
			EF 57	14	119 360	1940	Hi, Kr.	Hi, Kd.	19.920	18.020	2 C+C 2	4.240	9.100	100.5 (total)	—	12.66	6.15
			EF 58	84	178 880	1946	Hi, Ki, Kr, Mh, Ni, Ts.	Fu, Hi, Kd, Me, Ts, Ty.	19.900	18.100	2 C+C 2	4.220	9.000	67.9	29.8	13.06	6.48
			ED 42	28	29 760	1933	Ni, Ki, Kr, Mh.	Hi, Kd, Me, Ts.	12.810	9.000	B+B	2.500	5.400	57.5 (total)	—	14.47	—
			Note : Abbreviations under « Builder » denote :— Fu : Fugi Electric Mfg. Co.Ltd. Hi : Hitachi Ltd. Kd : Kawasaki Dock Yd. Co.Ltd. Ki : Kisha Seizo Kaisha Ltd. Kr : Kawasaki Rolling Stock Mfg. Co.Ltd. Me: Mitsubishi Elec. Mfg. Co.Ltd. Ty : Tayo Elec. Mfg. Co.Ltd. Mh : Mitsubishi Heavy Ind. R. Ltd. Ni : Nippon Sharyo Seizo Kaisha Ltd. Ts : Tokyo Shibaura Elec. Co.Ltd.														
19	U.S.A	Pennsylvania Railroad	GG 1	139	163 200 P	1935	G.E.Co. Baldwin or P.R.R.	G.E. or West	24.232	21.031	2 C+C 2	2.438	—	209 (total)	—	22.7	18.0
			GG 1		150 720 F	1937-1939	P.R.R.	»	24.232	21.031	2 C+C 2	2.438	—	216 (total)	—	22.9	19.7
			GG 1			1938	P.R.R.	»	24.232	21.031	2 C+C 2	2.438	—	212 (total)	—	22.7	19.1
			P 5*a*	91	102 912	1932-1933	G.E.Co. or Baldwin	G.E. or West	19.101	15.189	2—C—2	2.083	—	179 (total)	—	34.6	18.7
			P 5*a*			1935	» » »	»	19.101	15.189	2—C—2	2.083	—	179 (total)	—	34.6	18.7
			B 1	28	52 877	1933-1935	P.R.R.	W.E. or Al-Ch	9.601	3.860	C	—	—	71 (total)	—	23.8	—
			E 2*b*	6	71 248	1951-1953	G.E.Co.	G.E.Co.	16.535	12.141	B—B	3.353	8.788	111 (total)	—	27.8	—
			E 2*c*	2	71 776	1952	Baldwin	E.E.Corp.	18.898	13.157	C—C	5.003	10.262	164 (total)	—	27.4	—
			E 3*b*	2	65 840	1951	»	»	18.898	13.157	B—B—B	2.896	5.131	171 (total)	—	28.6	—

TABLE 2. — **General data concerning the various types of locomotives** *(continued)*.

No.	Country	Administration	Type or series	Normal service voltage	Characteristics of the traction motors								Transmission	Suspension of the traction motors
					Continuous rating				Hourly rating					
					Voltage	Current	Speed	Speed (tyres part worn)	Voltage	Current	Speed	Speed (tyres part worn)		
				kV	V	A	r.p.m.	km/h	V	A	r.p.m.	km/h		
16	POLAND	Polish State Railways	E 01 E 02 E 03 E 04 E 05	3 3 3 3 3	1 500 1 500 1 500 1 500 1 500	246 246 270 324 324	930 930 1 050 735 735	68 68 68 48 48	1 500 1 500 1 500 1 500 1 500	300 300 325 380 380	870 870 950 700 700	63.7 63.7 63.0 45.8 46.0	69/22 69/22 83/24 81/21 81/21	Tramway » » » »
17	SOUTH AFRICA	South African Railways and Harbours	1 E E S 2 E 3 E 4 E	3 3 3 3 3	1 450 1 450 — 1 450 1 450	153 153 — 210 232	1 470 1 470 1 470 1 285 1 450	72 72 72 104 96	1 450 1 450 — 1 450 1 450	208 208 — 250 282	— — — — —	— — — — —	Solid gear wheels » » » » » » "Silent-bloc" gear wheels » » » » } Unilateral Single Reduction Spur Gearing »	Axle-hung with nose suspension »
18	JAPAN	Japanese National Railways	EF 10 EF 11 EF 12 EF 13 EF 15 EF 16 EH 10 EF 53 EF 55 EF 56 EF 57 EF 58 ED 42	1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 0.6	— — — — — — — — — — — — —	— — — — — — — — — — — — —	— — — — — — — — — — — — —	— — — — — — — — — — — — —	— — — — — — — — — — — — —	— — — — — — — — — — — — —	— — — — — — — — — — — — —	— — — — — — — — — — — — —	Single reduction » » » » » » » » » » » » » » Rack : Double reduction. Adhesion : Jackshaft single reduction	Nose suspension » —
19	U.S.A.	Pennsylvania Railroad	GG 1 GG 1 GG 1 P 5*a* P 5*a* B 1 E 2*b* E 2*c* E 3*b*	11 11 11 11 11 11 11 11 11	320 320 320 260 260 235 750 512 512	1 185 1 185 1 185 2 700 2 700 780 2 700 690 690	1 900 1 900 1 900 885 885 475 735 590 590	145 161 161 79 79 25.6 42.6 27.3 27.3	— — — — — — — — —	— — — — — — — — —	— — — — — — — — —	— — — — — — — — —	Geared Quill » » » » » Gears » » »	Frame » » » » Axle-hung » » » »

TABLE 2. — **General data concerning the various types of locomotives** *(continued)*.

No.	Country	Administration	Type or series	Gear ratio	Diameter of driving wheels mm		Maximum speed authorised	Brief description of any connection between bogies	Remarks
					New	Worn	km/h		
16	POLAND	Polish State Railways	E 01 E 02 E 03 E 04 E 05	–	1 220 1 220 1 220 1 350 1 350	— — — — —	100 110 110 120 110	Rigid cardan joints. Without coupling. Elastic buffers. Elastic rods Transversely elastic cardan joints.	
17	SOUTH AFRICA	South African Railways & Harbours	1 E E S 2 E 3 E 4 E	1/4.41 1/4.41 1/4.41 1/3.08 1/3.57	1 220 1 220 1 220 1 220 1 295	1 143 1 143 1 143 1 143 1 220		Rigid hinged type of articulating joint for transmitting tractive effort. Type 4 E : Drawbar transmitting tractive effort transverse inter bogie control (spring controlled).	
18	JAPAN	Japanese National Railways	EF 10 EF 11 EF 12 EF 13 EF 15 EF 16 EH 10 EF 53 EF 55 EF 56 EF 57 EF 58 ED 42	1/4.15 1/4.15 1/4.15 1/4.15 1/4.15 1/4.15 1/3.67 1/2.63 1/2.43 1/2.63 1/2.63 1/2.68 A: 1/4.65 R: 1/3.72	1 250 1 250 1 250 1 250 1 250 1 250 1 250 1 250 1 250 1 250 1 250 1 250 1 070	1 154 1 154 1 154 1 154 1 154 1 154 1 154 1 154 1 154 1 154 1 154 1 154 874	75 75 75 75 75 75 85 110 110 110 110 110 30	Drawbar with spring buffers. » Drawbar with spring buffers. » » » » Ball joint. » » Drawbar with spring buffers. —	
19	U.S.A.	Pennsylvania Railroad	GG 1 GG 1 GG 1 P 5*a* P 5*a* B 1 E 2*b* E 2*c* E 3*b*	1/3.59 1/3.21 1/3.21 1/3.88 1/3.88 1/5.44 1/3.95 1/4.53 1/4.53	1 448 1 448 1 448 1 829 1 829 1 575 1 219 1 118 1 118	1 359 1 359 1 359 1 740 1 740 1 492 1 131 1 029 1 029	161 Pass. 145 Freight 113 113 40 105 105 105	Tractive power is delivered through driving boxes in articulated main frame to couplers. Lead trucks are connected through centre plates to main frame. (4-wheel lead trucks). Tractive power is delivered through driving boxes in main frame to couplers. Lead trucks are connected through centre plate to main frame. (4-wheel lead trucks). Tractive power is delivered through driving boxes in main frame to couplers. (No lead trucks). Tractive power is delivered through centre plates to cab frame couplers.	*Note :* Applies to GG 1 types only. Applies to P 5*a* types only.

TABLE 2. — **General data concerning the various types of locomotives** *(continued)*.

No.	Country	Administrations	Type or series	No. of locomotives	Average annual mileage km	Year of construction	Builder		Length over buffers m	Overall wheel-base m	Axle arrangement	Bogie wheel-base m	Distance between bogie pivots m	Weight in running order		Weight per driving axle (metric tons)	Weight per carrying axle (metric tons)
							Mechanical part	Electrical part						Mech. part (metric tons)	Elec. part including transmission (metric tons)		
20	SWEDEN	Swedish State Railways	Bg	—	110 100	1936	N	ASEA	11.900	8.000	—	—	5.200	68 (total)	—	17.0	—
			Bk	—	117 500	1939	M.F.N.	»	12.700	9.000	—	—	6.050	73.2 (total)	—	18.3	—
			Bs	—	110 100	1935	M.N.	»	11.900	8.000	—	—	5.200	68 (total)	—	17.0	—
			Da	—	132 300	1952	M.F.N.	»	13.000	9.400	—	—	—	52.6	22.4	15.0/17.0	15.0/12.2
			Df	—	141 400	1933	M	»	13.000	9.400	—	—	—	51.9	28.5	17.0	14.7
			Dg	—	141 400	1925	M.F.N.	»	13.000	9.400	—	—	—	51.9	28.5	17.0	14.7
			Dk	—	141 400	1933	M.F.N.	»	13.000	9.400	—	—	—	51.9	28.5	17.0	14.7
			Dr 2	—	141 400	1938	M.F.N.	»	13.000	9.400	—	—	—	50.5	28.5	17.0	14.7
			Ds	—	141 400	1925	M.F.N.	»	13.000	9.400	—	—	—	51.9	28.5	17.0	15.1
			Dg 2	—	141 400	1950	M	»	15.000	11.400	—	—	—	68.6	28.5	17.0	15.1
			Dm	—	71 500	1953	M.F.N.	»	25.100	21.370	—	—	—	135.2	44.8	17.0/19.0	12.0 14.0
			F	—	226 600	1942	M.F.N.	»	15.230	11.600	—	—	—	53.2	49.0	17.3	16.5
			Ha	—	69 400	1936	M.F. ASEA	»	11.720	7.850	—	—	5.350	50.6 (total)	—	12.7	—
			Hb	—	69 400	1939	F.N. ASEA	»	11.720	7.850	—	—	5.350	51.2 (total)	—	12.9	—
			He	—	106 700	1942	F.N. ASEA	»	12.500	—	—	—	5.700	59.8 (total)	—	15.0	—
			Hd	—	72 200	1942	N	»	12.500	8.500	—	—	5.700	62.2 (total)	—	15.75	—
			Hg	—	85 700	1947	M.F.N.	»	12.500	8.500	—	—	5.700	63.6 (total)	—	16.4	—
			Hg 2	—	85 700	1948	N	»	12.500	—	—	—	5.700	63.2 (total)	—	16.0	—
			Ma	—	212 600	1953	F	»	16.800	11.800	—	—	8.600	66.5	37.9	17.4	—
			Mg	—	131 800	1944	M.F.N.	»	16.800	12.000	—	—	8.600	52.4	49.6	17.0	—
			Od	—	50 500	1922	F	»	11.300	6.350	—	—	—	69.0 (total)	—	17.25	—
			Of 2	—	65 900	1922	M.F.	»	20.930	16.600	—	—	—	136.7 (total)	—	17.0	13.1
			Of 3	—	65 900	1922	M.F.	»	31.355	27.025	—	—	—	204.2 (total)	—	17.0	13.1
			Ra	—	145 500	1955	N ASEA	»	15.100	10.700	—	—	7.800	31.6	30.4	15.5	—
			Ub	—	54 800	1930	M.F.N.	»	9.600	4.100	—	—	—	31.0	16.4	15.8	—
			Ud	—	56 200	1955	M	»	9.600	4.100	—	—	—	50.4 (total)	—	17.0	—
			Ob	—	17 500	1932	ASEA	»	9.600	4.500	—	—	—	36.0 (total)	—	18.0	—
			Oc	—	18 900	1935	ASEA	»	11.300	7.850	—	—	5.350	47.0 (total)	—	12.0	
			Od	—	27 100	1942	ASEA	»	12.200	8.200	—	—	5.700	62.6 (total)	—	15.3	
			Note : Abbreviations under « Builder » denote : M = Ab Motala verkstad. F = AB Svenska Jarnvagsverkstaderna, Falun. N = Nydkvist & Holm AB.														
21	SWEDEN	Stockholm-Roslagen Jarnvager	50	1	92 800	1944	ASEA	ASEA	9.99	7.40	Bo — Bo	2.20	5.20	25.40 (total)	—	6.35	—
			51-52	2	112 000	1942	»	»	11.30	7.90	Bo — Bo	2.40	5.50	36.00 (total)	—	9.00	—
			53	1	64 000	1947	Siemens — Schuckert	Siemens — Schuckert	11.30	7.90	Bo — Bo	2.40	5.50	36.00 (total)	—	9.00	—
			54-55	2	120 000	1946	ASEA	ASEA	11.30	7.90	Bo — Bo	2.40	5.50	36.00 (total)	—	9.00	—
			Motor-Coaches													7.59	
			15, 16, 17	3	86 400	1919	»	»	17.95	12.81	Bo — Bo	1.91	10.90	30.35 (total)	—	6.71	—
			18, 19	2	144 000	1934	»	»	17.85	14.10	Bo — Bo	2.10	12.00	26.85 (total)	—	7.45	—
			121-128	8	112 000	1939	»	»	18.45	15.10	Bo — Bo	2.10	13.00	29.80 (total)	—	7.45	—
			129	1	112 000	1940	»	»	18.45	15.10	Bo — Bo	2.10	13.00	29.80 (total)	—	8.35	—
			130-137	8	168 000	1946	ASJ	»	19.05	16.45	Bo — Bo	2.40	14.05	33.40 (total)	—	8.55	—
			138-140	3	168 000	1949	ASEA	»	19.05	16.45	Bo — Bo	2.40	14.05	34.20 (total)	—		
22	U.K.	London Transport	—	15	57 445	1922	Metro/Vick	Metro/Vick	12.039	8.991	Bo — Bo	2.819	6.172	61.4 (total)	—	15 3	15 3
23	U.K.	British Railways	EM 1	58	68 000	1941-1953	B.R.	Metro/Vick	15.342	10.668	Bo + Bo	3.505	7.163	49.0	39.1	22.3	—
			EM 2	7	124 000	1953-1954	B.R.	» »	17.983	14.072	Co — Co	4.775	9.296	65.0	38.6	17.3	—
24	INDIA	Indian Government Railways	EA 1	23	113 600	1928-1930	Swiss Loco. Co.	Metro/Vick	16.307	11.887	1—AAA—2	2.438	7.060	67.5	36.6	21.5	13.2
			EB 1	1	38 400	1928	Hawthorne Leslie	G.E.C.	17.120	13.208	2—AAA—2	2.134	11.075	70.1	42.3	20.1	13.2
			EC 1	1	59 200	1928	—	Brown Boveri	17.112	14.021	2—AAA—2	2.743	11.278	67.0	45.7	19 5	13.6
			EF 1	41	56 000	1928	Vulcan Foundry & S L M	Metro/Vick	20.142	16.739	C — C	4.597	9.144	74.7	50.3	20.8	—
			EM 1	7	—	1954	Vulcan Foundry	English Electric	20.833	15.418	Co — Co	4.801	10.617	125.0 (total)	—	20.8	—

TABLE 4.

No.	Country	Administration	Max. speeds authorised for passenger trains km/h	Approx. normal speed of passenger trains stops not included km/h	Approx. normal speed of freight trains km/h
16	POLAND	Polish State Railways	100	75	44
17	SOUTH AFRICA	South African Railways and Harbours	88	56 — 88	24 — 56 Block loads of bo gie stock only 88.
18	JAPAN	Japanese National Railways	95	Limited Express 79.6 Express 71.6 Ordinary 53.2	51.2
19	U.S.A.	Pennsylvania Railroad	129	New York-Washington 105 East-West Service 69 Local Service 48	56
20	SWEDEN	Swedish State Railways	130	Express 71 —102 Ordinary 61	Express 75 Ordinary 48 Local 40
21	SWEDEN	Stockholm Roslagens Jarnvager	75	45 — 50	30
22	UNITED KINGDOM	London Transport	104	54	—
23	UNITED KINGDOM	British Railways	104	96	40 — 48
24	INDIA	Indian Government Railways	104	Express 54 Slow 48	32

TABLE 5. –

No.	Country	Administration	Chemical analysis					
			C %	Mn %	Si %	P %	S %	Observations
16	POLAND	Polish State Railways	—	—	—	—	—	—
17	SOUTH AFRICA	South African Railways and Harbours	0.55-0.68	0.70-0.90	0.10-0.30	0.5 max.	0.6 max.	H COB Rail — Open Hearth Basic
			0.50-0.60	0.90-1.20	0.10-0.30	0.5 max	0.6 max.	M MOB Rail — Open Hearth Basic
18	JAPAN	Japanese National Railways	0.55-0.70	0.60-0.95	0.40 or less	0.045 or less	0.05 or less	30/37 kg rail
			0.60-0.75	0.60-0.95	0.40 or less	0.045 or less	0.05 or less	50 kg rail
19	U.S.A.	Pennsylvania Railroad	0.55-0.68	0.60-0.90	0.10-0.23	0.04	—	32/36 kg rail Open Hearth
			0.64-0.77	0.60-0.90	0.10-0.23	0.04	—	37/41 kg rail »
			0.67-0.80	0.70-1.00	0.10-0.23	0.04	—	41/54 kg rail »
			0.69-0.82	0.70-1.00	0.10-0.23	0.04	—	55 kg and over »
20	SWEDEN	Swedish State Railways	0.55-0.65	0.90-1.10	0.15-0.30	0.04 max.	0.04 max.	Electric Steel Proces
21	SWEDEN	Stockholm-Roslagens Jarnvager	—	—	—	—	—	—
22	UNITED KINGDOM	London Transport	—	—	—	—	—	—
23	UNITED KINGDOM	British Railways	0.40-0.50	0.95-1.25	0.08-0.20	0.06 max.	0.06 max.	Acid Bessemer
			0.50-0.60	0.95-1.25	0.08-0.20	0.06 max.	0.06 max.	Open Hearth
24	INDIA	Indian Government Railways	0.50 -0.60	0.60 -0.90	0.05 min.	0.06 max.	0.05 max.	23 kg or under — Acid or Basic
			0.55-0.68	0.65-0.90	0.05 min.	0.05 max.	0.05 max.	25/41 kg — Open Hearth
			0.58-0.68	0.65-0.90	0.05 min.	0.05 max.	0.05 max.	41/42 kg — or Acid Bessemer

Tensile breaking stress	*Coefficient of quality*	*Approved limit of elasticity in tension*	*Minimum resilience*	*Brinell hardness*	*Observations*
80 kg/mm²	—	—	—	230	—
2.5-86.6 kg/mm²	—	—	10 %-12 %	—	Test Piece 14.33 mm diameter
2.5-86.6 kg/mm²	—	—	9 %-12 %	—	50.80 mm between marks.
) kg/mm² or more	—	*	*	—	* Not specified-elongation of steel used is 9 % or more 30/37 kg rail 8 % or more 50 kg rail.
5 kg/mm² or more	—	*	*	—	
91 kg/mm²	—	49 kg/mm²	—	260	—
91 kg/mm²	—	49 kg/mm²	—	260	—
91 kg/mm²	—	49 kg/mm²	—	260	—
91 kg/mm²	—	49 kg/mm²	—	260	—
80 kg/mm²	—	—	12 %	217 min.	Test piece 1 = 5d.
—	—	—	—	—	—
—	—	—	—	—	—
69 kg/mm²	—	—	11 % min.	—	—
72 kg/mm²	—	—	11 % min.	—	—
—	—	—			—
—	—	—		—	—
—	—	—	—	—	—

TABLE 5. –

No.	Country	Administration	Chemical analysis					Observations
			C %	Mn %	Si %	P %	S %	
16	POLAND	Polish State Railways	0.55	—	—	0.06	0.05	—
17	SOUTH AFRICA	South African Railways and Harbours	—	—	—	0.05 max.	0.05 max.	Acid Open Heart
18	JAPAN	Japanese National Railways	0.60-0.75	0.50-0.75	0.15-0.35	0.055 or less acid 0.05 or less Basic	0.05 or less	—
19	U.S.A.	Pennsylvania Railroad	0.60-0.75	0.50-0.75	0.15-0.35	0.05 max.	0.05 max.	Class B
			0.70-0.85	0.50-0.75	0.15-0.35	0.05 max.	0.05 max.	Class C
20	SWEDEN	Swedish State Railways	0.55-0.65	0.60-0.80	0.25-0.45	0.04 max.	0.035 max.	Class ST 72-432 Ty Sour Martin Proces
			0.70-0.80	0.60-0.80	0.25-0.45	0.04 max.	0.035 max.	Class ST 88-432 Ty Sour Martin Proces
21	SWEDEN	Stockholm-Roslagens Jarnvager	0.55-0.65	0.90-1.10	0.15-0.30	0.04 max.	0.04 max.	—
22	UNITED KINGDOM	London Transport	—	—	—	—	—	—
23	UNITED KINGDOM	British Railways	—	—	—	0.05 max.	0.05 max.	Acid or Basic Ope Hearth or Electr
24	INDIA	Indian Government Railways	—	—	—	0.05 max.	0.05 max.	Acid or Basic Ope Hearth

s.

Tensile breaking stress	*Coefficient of quality*	*Approved limit of elasticity in tension*	*Minimum resilience*	*Brinell hardness*	*Observations*
70 kg/mm²	—	—	—	200	—
99-109 kg/mm²	—	—	—	—	—
80- 98 kg/mm²	—	(*)	(*)	—	(*) Not specified — elongation of steel is 10 % or more 6 160 — 7 470 kg/cm.
8[illegible] kg/mm²	—	10 % in 51 mm	14 % reduction of area	—	—
88 kg/mm²	—	8 % in 51 mm	12 % reduction of area	—	—
2-82 kg/mm² min.	—	—	15 % min.	200-220	Test piece 1 = 5*d*
8-98 kg/mm² min.	—	—	9 % min.	220-240	Test piece 1 = 5*d*
80 kg/mm²	Est'd Rt + 2.7 × elongation = 107	40 or 50 kg/mm² estimated	Estimated to Charpy-Key-hole min. 1.5 kg/cm² at 20°C	217	—
—	—	—	—	—	—
88-98 kg/mm²	—	—	13 % to 11 %	—	(*) Standard proportional round tensile test piece.
99-109 kg/mm²	—	10 %	Min. yield point 50 % of tensile strength	—	—

TABLE 6.

No.	*Country*	*Administration*	*Running surface* mm	*Flange* mm	*Remarks*
16	*POLAND*	*Polish State Railways*	10.0	—	Total maximum wear of running surface is 40 mm.
17	*SOUTH AFRICA*	*South African Railways and Harbours*	6.4	9.5	Flange wear at 14.3 mm from top of flange — minimum flange angle and tip radius is also specified.
18	*JAPAN*	*Japanese National Railways*	—	—	*(a)* The wear limit is 32 mm - new tyres are 80 mm thick. *(b)* Three cases of flange wear are specified : (i) When the diametrical distance between the top of the flange and a specified point on the flange becomes 1.5 mm. (ii) When the diametrical distance between the top of the flange and a specified point on the flange becomes 3 mm with a flange angle 17°. (iii) When the thickness of the flange is reduced by 11 mm at a point 10 mm below the centre of the tread.
19	*U.S.A.*	*Pennsylvania Railroad*	7.9 (Road service locomotives) 9.5 (Switching service locomotives)	— —	Flange — minimum thickness from back to tyre 23.8 mm.
20	*SWEDEN*	*Swedish State Railways*	7.0	12.5	Flange — total wear on both wheels of the same axle must not exceed 15 mm.
21	*SWEDEN*	*Stockholm-Roslagens Jarnvager*	—	—	The total maximum wear of running surface is 20/25 mm for the new tyres at 65/70 mm.
22	*UNITED KINGDOM*	*London Transport*		—	—
23	*UNITED KINGDOM*	*British Railways*	7.9	7.5	*Flange — wear measured at a distance of 14.3 mm from top of flange.
24	*INDIA*	*Indian Government Railways*	6.4	6.4	—

TABLE 7.

No.	*Country*	*Administration*	*Average run between two turnings of the tyres, km*
16	*POLAND*	*Polish State Railways*	100 000
17	*SOUTH AFRICA*	*South African Railways and Harbours*	1 E & 2 E 192 000 3 E 320 000 (With position interchange) 4 E 128 000
18	*JAPAN*	*Japanese National Railways*	Passenger 60 000 Freight 50 000 Others 42 000
19	*U.S.A*	*Pennsylvania Railroad*	GG-1 226 000 P. 5 58 000
20	*SWEDEN*	*Swedish State Railways*	Varying between 150 000 and 400 000
21	*SWEDEN*	*Stockholm-Roslagens Jarnvager*	100 000
22	*UNITED KINGDOM*	*London Transport*	—
23	*UNITED KINGDOM*	*British Railways*	EM. 1 92 000 EM. 2 112 000
24	*INDIA*	*Indian Government Railways*	EA/1, EB/1, EC/1 X 200 000 EF/1 120 000 EM/1 64 000

TABLE 9. — **Dimensions and tolerances for brushes and brush holders.**

POLAND

POLISH STATE RAILWAYS

Play — Width 0.05 mm minimum
0.61 mm maximum

Thickness 0.02 mm minimum
0.23 mm maximum

SOUTH AFRICA

SOUTH AFRICAN RAILWAYS AND HARBOURS

Locomotive type 1 E, ES, 2 E, 3 E :

$(31.8^{+\ .00}_{-\ .08}) \times (15.9^{+\ .00}_{-\ .08}) \times (57.2^{+1.00}_{-\ .00})$ mm long

Wearing length 25.4 mm

Locomotive type 4 E :

$(31.8^{+\ .00}_{-\ .08}) \times (\ 9.5^{+\ .00}_{-\ .08}) \times (57.2^{+1.00}_{-\ .00})$ mm long

Wearing length 25.4 mm

JAPAN

JAPANESE NATIONAL RAILWAYS

Type of traction motor — MT 17, 17 A, etc. :

40 · 25 · 64 mm

Type of traction motor — MT 38, 39, 41, etc. :

50 · 25 × 64 mm

Limit of play specified at 0.25 mm

TABLE 8. — **General data concerning the traction motors.**

No.	*Country*	*Administration*	*Type of locomotive*	*Type of motor*	*Number of main and auxiliary poles*	*Number of brush lines*	*Number of brushes per line*	*Number of commutator segments*	*Type of armature bearing*	*Type of axle or hollow shaft bearing*	*Method of lubricating armature and axle or hollow shaft bearing*	*Insulation used in construction (Modern insulants with Silicone bases, etc.)*	*Diagram of circulation of ventilating air*	*Weight of motor with gearbox, without transmission, etc.*
16	*POLAND*	*Polish State Railways*		MV. 185	4 + 4	4	2	400	Friction	Friction	Roller bearings — T 2 Grease	—	—	4 815
				MV. 185. Re	4 + 4	4	2	400	Roller	»		—	—	4 815
				LJB. 117	4 + 4	4	2	378	»	»	Friction bearings — Machine Oil	—	—	4 637
				GBM. 530	4 + 4	4	2	462	»	»		—	—	6 250
17	*SOUTH AFRICA*	*South African Railways and Harbours*	1 E 2 E											
			3 E E S	—	4 + 4	4	2	343	Roller	Plain axle	Oil in woollen waste packing (All bearings)	Class 'B' only	—	4 191
			4 E	—	4 + 4	4	2 × 2	335	»	»	» » » » »		—	4 700
18	*JAPAN*	*Japanese National Railways*			4 + 4 (some with 6)	4 (some with 6)	2	171	Old type — plain	Plain axle	Roller bearings — Grease	Class 'B' — Glass fibre. Silicone base experimentally	Forced air — parallel	3 500 — (EF. 13. 15.58, EH.10)
									New type — roller	»	Plain bearings — Pads and machine oil — Some felt lubricators			3 100 — (EF. 10)
														4 500 — (ED. 42)
19	*U.S.A.*	*Pennsylvania Railroad*	GG. 1	—	12 + 12	12	4	612	Roller	Plain axle	Roller bearings — Grease	Mica Glass — coils. Mica and rag paper-slots (Some mica silicone in use)	Self ventilated axial flow	6 010 GG. 1
			P 5 A	—	18 + 18	18	5	459	»	»	Plain bearings — Oil wicks			13 455 P 5 A
														14 500 B. 1
20	*SWEDEN*	*Swedish State Railways*	F.	KJ. 106	20 + 20	10	5	375	Roller	Roller bearings	Grease	Mica paper — asbestos paper strips — glass fibre strips (Ra)	*Type F* — Axial from back end to front end of stator. Axial from front end to back end of Rotor.	4 600
			M.	KJ. 88	16 + 16	8	5	276	»	»	»			3 100
			Ma.	KJ. 88	16 + 16	8	5	276	»	»	»		*Types M, Ma, Ra* — Axial from back end to front end of Rotor.	3 100
			Ra.	KJB. 97	20 + 20	10	4	375	Roller Ball	»	»			2 400
21	*SWEDEN*	*Stockholm - Roslagens Jarnvager*	—	LJB. 42	4 + 4	4	1	185	Roller	Plain axle	Oil wicks	Motor — Class 'B' — Magnet and interpole coils — glass and mica fabric.	—	875
			—	LJB. 62	4 + 4	4	2	185	»	»	»		—	1 215
			—	LJB. 62*a*	4 + 4	4	2	225	»	»	»		—	1 215
22	*UNITED KINGDOM*	*London Transport*	Met-Vick	339 V	4 + 4	2	4	159	Roller	Plain axle	Oil soaked packing	Class 'B'	—	3 618
23	*UNITED KINGDOM*	*British Railways*	EM. 1	—	4 + 4	4	3	153	Roller	Plain axle	Oil with cotton waste	Class 'B' — *Armature* — Bakelised cambric, asbestos, cotton mica tape, mica paper sandwich, moulded micanite. *Field Coils* — as above plus cotton tape, asbestos paper.	Forced air — enters at commutator end, discharged by Fan at top and bottom of casing, pinion end. Deflector at bottom outlet.	4 368
			EM. 2	—	4 + 4	4	3	230	»	»	»			2 981
24	*INDIA*	*Indian Government Railways*	EF. 1	—	4 + 4	4	3	432	Plain	Plain axle	Oil rings and grease	Mica and Bakelite	Forced air	7 457
			EA. 1	—	4 + 4	4	2	161	»	»	»			3 364
			EM. 1	—	4 + 4	4	3	232	Roller	»	»	EM1. Mica and Glass		3 603

TABLE 9. — **Dimensions and tolerances for brushes and brush holders** *(continued)*.

U.S.A.

PENNSYLVANIA RAILROAD

Locomotive type GG 1 :

The brush holder box has two slots of 121.4 × 57.2 × 9.6 mm with tolerance of $^{+\ 0.05}_{-\ .000}$ mm.

Locomotive type P 5 a :

The brush holder box has two slots of 121.4 × 57.2 × 9.6 mm and one slot 61.1 × 57.2 × 9.6 mm with tolerance of $^{+0.05}_{-\ .000}$ mm.

Brush sizes = 9.5 × 60.3 × 69.9 mm
Brush limit = 50.8 mm

Brush tolerances :

Nema carbon graphic, electro-graphite :

Length	= + .000 mm, − .800 mm
Width, 19.1 mm and under	= + .000 mm, − .100 mm
Width over 19.1 mm	= + .000 mm, − .400 mm
Thickness	= + .000 mm, − .100 mm
Diameter	= + .000 mm, − .100 mm

SWEDEN

SWEDISH STATE RAILWAYS

Dimensions of brushes = $(12.5^{+\ .000}_{-\ .080}) \times (45.0^{+\ .000}_{-\ .080}) \times (55.0^{+\ .000}_{-\ .500})$ mm

holder = $(12.5^{+\ .120}_{+\ .050}) \times (45.0^{+\ .120}_{+\ .050})$ mm

No special limits in service.

TABLE 9. — **Dimensions and tolerances for brushes and brush holders** *(continued)*.

SWEDEN

STOCKHOLM - ROSLAGENS JARNVAGER

Motor type LJB 30

Dimensions of brush = 50 × 40 × 16 mm
Dimensions of holder = 40.2 × 16.2 mm

Motor type LJB 42

Dimensions of brush = 50 × 40 × 16 mm
Dimensions of holder = 40.2 × 16.2 mm

Motor type LJB 62

Dimensions of brush = 50 × 25 × 22 mm
Dimensions of holder = 25.2 × 22.2 mm

Motor type Dd 1203 K

Dimensions of brush = 50 × 40 × 20 mm
Dimensions of holder = 40.2 × 20.2 mm

Tolerance of brushes $\pm\ ^{0.1}$ mm

Play of brushes in holder must not exceed 0.3 mm.

UNITED KINGDOM

LONDON TRANSPORT

Dimensions of brushes and holders :

$$(69.9^{+\ .800}_{-\ .800}) \times (50.8^{+\ .000}_{-\ .200}) \times (19.1^{+\ .000}_{-\ .100})\ \text{mm.}$$

Tolerances on brush boxes :

Thickness $(19.1^{+\ .125}_{-\ .025})$ Width $(101.6^{+\ .200}_{-\ .025})$ mm.

No special limits in service.

TABLE 9. — **Dimensions and tolerances for brushes and brush holders** *(continued)*.

UNITED KINGDOM

BRITISH RAILWAYS

Locomotive type EM 1 :

Dimensions of brush = $(38.1^{+\ .000}_{-\ .200}) \times (20.3^{+\ .000}_{-\ .200}) \times 57.2$ mm

Dimensions of holder = $(38.1^{+\ .050}_{+\ .400}) \times (20.3^{+\ .025}_{+\ .050})$ mm

Clearance between brush and new brush holder :

Width $^{+\ .050}_{-\ .600}$ mm

Thickness $^{+\ .025}_{-\ .250}$ mm

Locomotive type EM 2 :

Dimensions of brush = $(50.8^{+\ .000}_{-\ .100}) \times (15.9^{+\ .000}_{-\ .100}) \times 57.2$ mm

Dimensions of holder = $(50.8^{+\ .050}_{+\ .150}) \times (15.9^{+\ .025}_{+\ .150})$ mm

Clearance between brush and new brush holder :

Width $^{+\ .050}_{-\ .250}$ mm

Thickness $^{+\ .025}_{-\ .250}$ mm

No special limits in service.

INDIA

INDIAN GOVERNMENT RAILWAYS

Locomotive type EA 1 :

Brushes = 57.2 × 57.2 × 19.1 mm

Holder = 129.4 × 120.7 × 91.3 mm

Locomotive type EB 1 :

Brushes = 57.2 × 50.8 × 25.4 mm

Locomotive type EC 1 :

Brushes = 54.8 × 39.7 × 19.8 mm

Locomotive type EF, 1 :

Brushes = 57.2 × 44.5 × 15.9 mm

Holder = 149.2 × 128.6 × 96.8 mm

Locomotive type EM/1 :

Brushes = 54.0 × 44.5 × 19.1 mm

Holder = 209.6 × 166.7 × (?) 76.2 mm.

TABLE 10. — **Lubricants used in the bearings and gears.**

POLAND		
POLISH STATE RAILWAYS		
Bearings		*Gears*
Armature	*Axle*	
T.2	Machine Oil	—

SOUTH AFRICA		
SOUTH AFRICAN RAILWAYS AND HARBOURS		
Bearings		*Gears*
Armature	*Axle*	
Motor Bearing Grease —	SAE.40 SAE.60	Caltex Crater Compound No. 2 Caltex Crater Compound No. 5 Vacuum Meropa 10.

TABLE 10. — **Lubricants used in the bearings and gears** *(continued)*.

JAPAN				
JAPANESE NATIONAL RAILWAYS				
Characteristics	*Bearings*		*Gears*	
	Armature	*Axle*	*Cylinder Oil & Blown Asphalt*	
	Mineral Oil & Soap	*Mineral Oil & Soap*	*Hard Gear Compound*	*Soft Gear Compound*
Consistency at 25°C	230 ± 10	190 ± 15	300 — 350	350 — 400
Dropping Point	150°C or more	150°C or more	—	—
Flash Point	150°C or more	180°C or more	200°C or more	200°C or more
Viscosity at 50°C	160 or more	270 or less	—	—
Viscosity at 100°C	—	50 or more	—	—
Solidifying Point	—10°C or less	—	—	—
Free Alkali (Na_2O)	0.1 % or less	0.1 % or less	—	—
Ash Content	4 % or less	5 % or less	1 % or less	1 % or less
Water Content	0.5 % or less	1 % or less	1 % or less	1 % or less
Corrosion Test	Good	Good	Good	Good
Stability (105°C < 8 h)	Good	Good	—	—

U.S.A.		
PENNSYLVANIA RAILROAD		
Bearings		*Gears*
Armature	*Axle*	
Non-fibrous grease — 17 % sodium, 3 % lime soaps as a base — worked consistency 270 — 300 secs. at 77°F.	A.A.R. Specification M.906 — Journal box oil.	Grease compound with straight mineral characteristics — viscosity 200 secs. at 210°F.

TABLE VI — Lubricants used in the bearings and gears (continued)

[illegible]		
[illegible]		
Bearings		Gears
Axleboxes	Other Gears	
SKF — [illegible] From [illegible] SKF [illegible] and Vacuum [illegible]	[illegible] SKF [illegible]	Gear shaft roller bearings — grease SKF-1. Gear shaft plain bearings — wagon axle box oil in summer, locomotive axlebox oil in winter.

SWEDEN			
[illegible] — [illegible]			
[illegible]	Bearings		Gears
	Axleboxes	Axles	
	SKF — [illegible]	Oil	Oil
[illegible] Penetrating Quality at 25°C Penetrating Quality at 0°C [illegible] Alkali Content Water Content Solubility Emulsion Test Fe Soap [illegible]	Medium compact At delivery 220-260 At working A.S.T.M. 250-290 [illegible] Ca 4.2 % Ca 3.0 % Insoluble Very Good 30°C to + 50°C	Light Machine 4 ½° engl.	Heavy Cog :— Viscosity 50°C max. 430 cst. 100°C 33 ± 5 cst. Lowest floating temp. max. 0°C.

TABLE 10. — **Lubricants used in the bearings and gears** *(continued)*.

UNITED KINGDOM		
BRITISH RAILWAYS		
Bearings		*Gears*
Armature	*Axle*	
Regal Starfak No.2 Grease Regent Oil Co.Ltd.	Ammoral 'B' Oil — Gulf Oil Co.Ltd.	Gargoyle Compound No. 8 - Vacuum Oil Co.Ltd.

INDIA		
INDIAN GOVERNMENT RAILWAYS		
Bearings		*Gears*
Armature	*Axle*	
High Viscosity Mineral Oil	High Viscosity Mineral Oil	High Viscosity Mineral Oil

TABLE 11. — General dimensions

No.	Country	Administration	Number of strips	Dimensions mm
16	POLAND	Polish State Railways	—	30 × 6 30 × 10
17	SOUTH AFRICA	South African Railways and Harbours	4	25.4 × 6.4
18	JAPAN	Japanese National Railways	8	25 × 10
19	U.S.A.	Pennsylvania Railroad	2	120.7 × 3.2
20	SWEDEN	Swedish State Railways	1	33 × 57 (530 + 530)
21	SWEDEN	Stockholm - Roslagens Jarnvager	2	44 × 14
22	UNITED KINGDOM	London Transport	—	—
23	UNITED KINGDOM	British Railways	8	31.8 × 6.4 (operates with two pantograph
24	INDIA	Indian Government Railways	*	30.2 × 6.4 * It is not quit

ubbing strips of pantographs.

Material	*Fastening*	*Measures taken to avoid arcing between strip and bow*	*Maximum wear allowed*
pper	Screw	—	Minimum thickness 2 mm
pper with 1 % cadmium	Screw	No special precautions taken	3.2 mm
ıtered pper ı ən ckel raphite	Screw	No special precautions taken	8 mm
pper bearing steel	Bolt	Copper flexible shunt between tubing and horn	—
ırbon	Elastically with assisting clamping screws	Screws so arranged to avoid arcing between strips and bow	20 mm
uminium 90 % pper 10 %	Bolt	—	10 mm
ourth rail system	—	—	—
opper ur strips on each pan)	Screw	No special precautions taken	4.8 mm
opper bearing steel	Screw	—	4.4 mm

ear whether these are two or four strips.

OBITUARY.

René CLAUDON,

General Inspector of Bridges & Highways,
Vice-President of the Administrative Council of the French National Railways,
Member of the Permanent Commission of the International Railway Congress Association.



We have learnt with great regret of the death on the 30th January last of M. René CLAUDON, Vice-President of the Administrative Council of the French National Railways, a member of the Permanent Commission of our Association.

M. CLAUDON, the son of a railwayman, was born in 1892 at Saint-Remy en Rollat (Allier). After a brilliant scholastic career, he obtained both the diploma of mathematical sciences (teaching diploma) and the degree of doctor of law, legal science and political and economic sciences. His career was very brilliant and devoted throughout to the service of the State. He started in the Bridges and Highways Department as an ordinary engineer in 1917, and was promoted to chief engineer of Bridges and Highways (Upper-Rhine and Sarthe) in 1927. In 1938, he was appointed first class general inspector of Bridges and Highways.

He entered the Ministry of Public Works and was appointed State Councillor, Staff Manager of the Accounts and General Administrative Department. Later on, he took over the duties of general manager of the Railways and Transport Department, a post which he held for six years. It was whilst he held this post that, during the negociations which culminated in the signing of the Convention of the 31st August 1937, he was one of the promotors of the formula of an organisation having complete autonomy, which was made use of when the S.N.C.F. was created.

From September 1939 to June 1940, he was given the title of General Transport Manager with high ranking officers of the three armed forces as his assistants. In 1942, during the period of occupation, he had to give up the General Managership of the Railways and was nominated governor of the Polytechnique School during the years 1943-1944, in which post his

work earned him the appointement of honorary governor after the Liberation. In 1945, he took over the duties of temporary administrator and general manager of the Paris Metropolitan Company.

From this time, he devoted all his activities to the management of the S.N.C.F., of which he had been appointed administrator in 1944; in 1950, he was promoted to Vice-President of the Administrative Council.

His attainments during his career in his own country also led M. CLAUDON to be offered high ranking posts both on the overseas railways and in national industry, amongst which we may mention : President of the Algerian Railways, President of the Mediterranean-Niger Railway, Member of the Administrative Council of the Alsace Domanial Potash Mines, Member of the Administrative Council of the Office of the French Overseas Railways.

Numerous French and foreign orders awarded to him bear testimony to his devotion and merits : M. CLAUDON was a commander of the Legion of Honour, grand officer of Polonia Restituta, grand officer of Nicham Alaouite and grand officer of the Black Star.

M. CLAUDON was nominated a member of the Permanent Commission of the International Railway Congress Association in July 1938.

In spite of his heavy duties, he always showed the greatest interest in the work of our Association. In particular, we may recall his participation in the Rome Congress in 1950, when he was President of the First Section (Way and Works).

M. CLAUDON was always a faithful friend of our Association and his affable character earned him the sympathy and admiration of all his colleagues on the Permanent Commission.

We offer his family our sincere condolences.

The Executive Committee.

ADDENDUM

[625 .143 .3]

Report on Question 9 (17th Session, Madrid 1958),

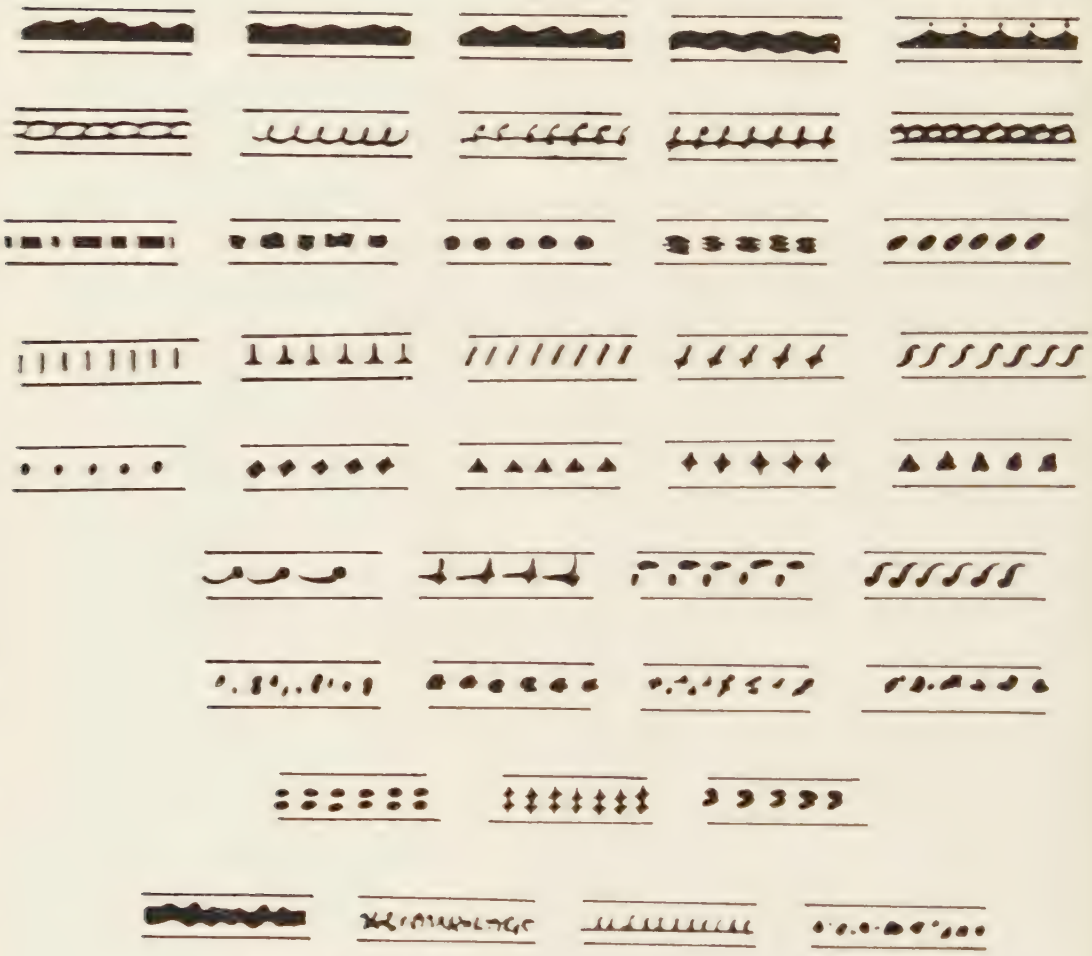
by Luis Prieto DELGADO.

(See *Congress Bulletin* for June 1958, p. 963/57.)

After p. 990/84, please add the following :

Appendices I to VII.

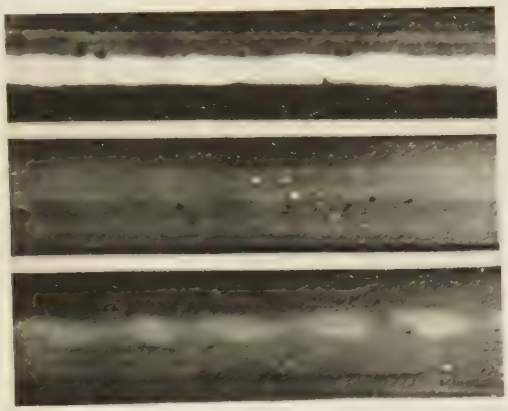
APPENDIX 1

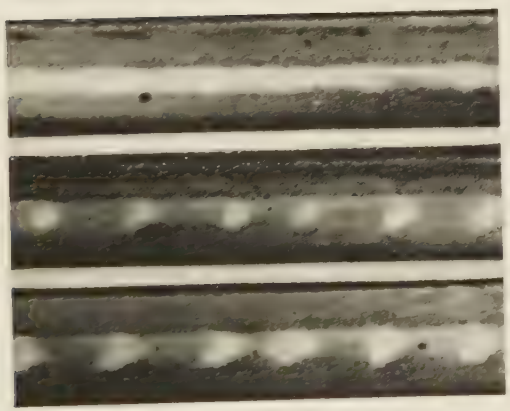


Shapes of the crests due to some kind of undulatory wear.

a. Beaked crests
g. Irregular crests
h. Double crests.
i. Special shaped crests.

APPENDIX II





Development of short wave undulatory wear.

a. Martin Siemens steel rail undulated after 3, 4 and 5 years in service.

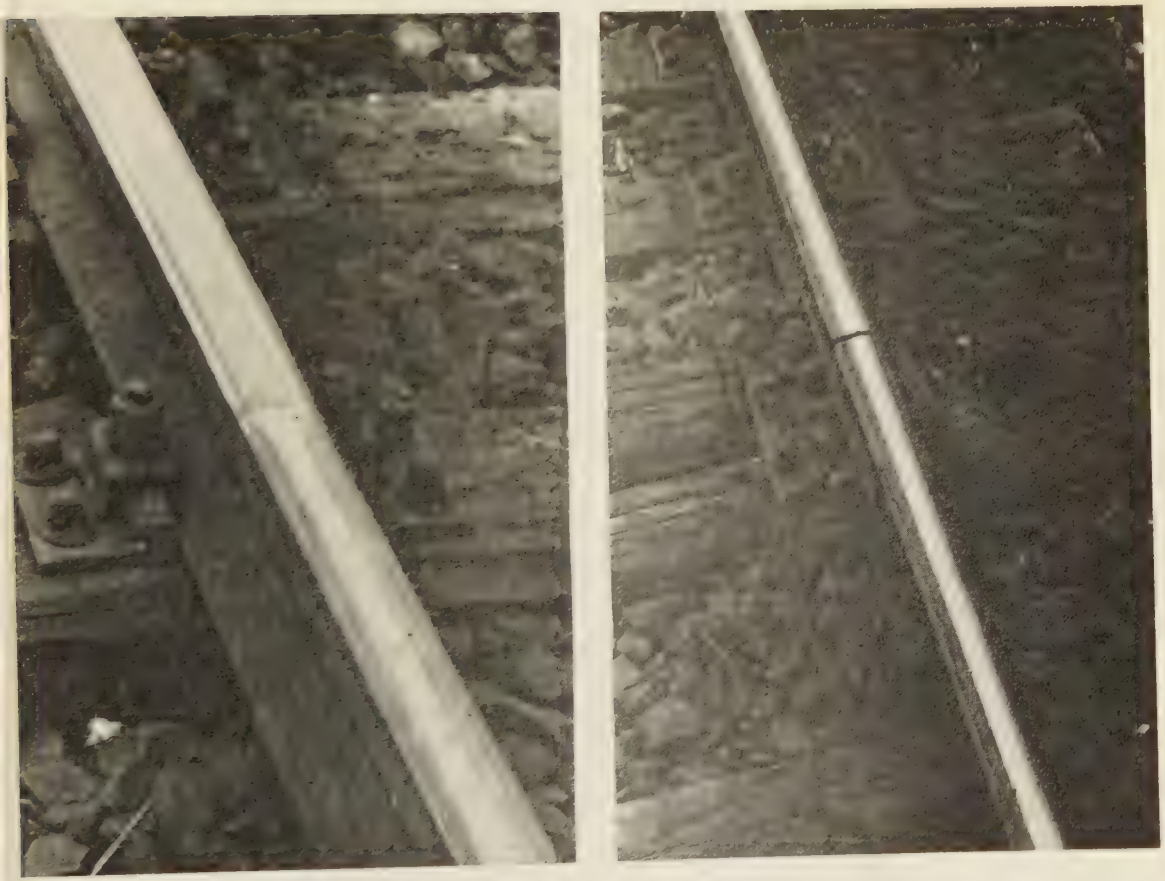
b. Thomas steel rail undulated after 3, 4 and 5 years in service.

(Courtesy Federal Railways)





APPENDIX IV



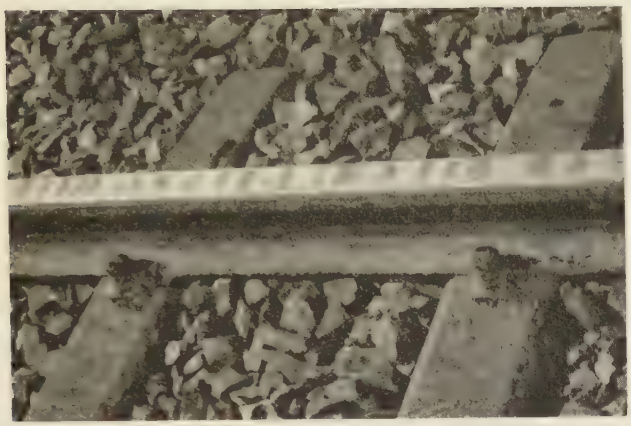
Welded rails and rails with joint showing various undulations characterised by the nature of each rail

APPENDIX V

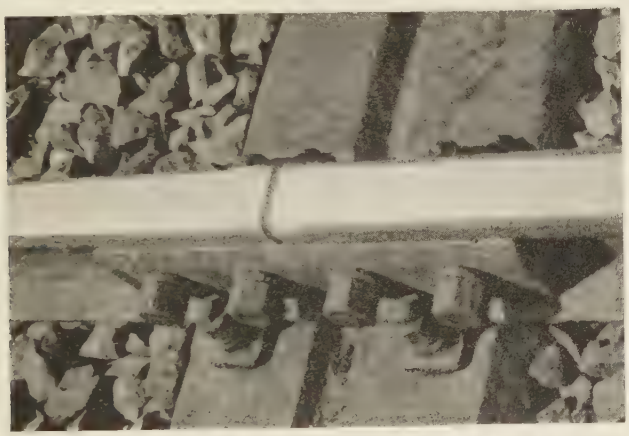


Short wave undulatory wear recorded on the tyre of a carrying axle of an electric locomotive.
Swiss Federal Railways.

a.



b.



c.

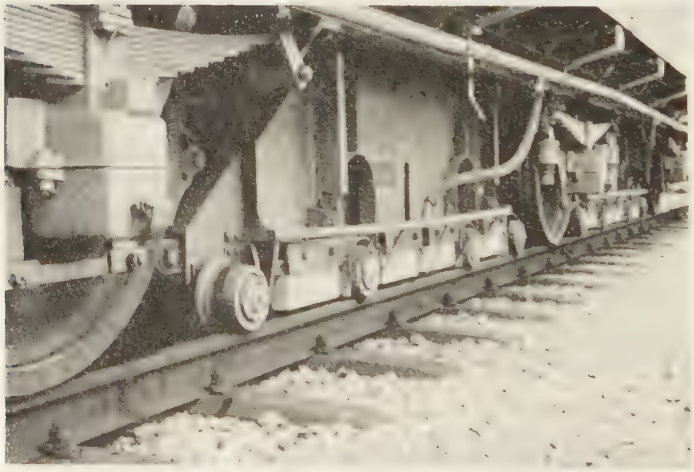


a. Short waves during grinding.
b. Rail joints after grinding.
c. Running surface after grinding.
Swiss Federal Railways.

a.



b.



a. Grinding train with rotating grinding wheels (Krupp).
b. Grinding train with abrasive shoes (Scheuchzer).

[625 .216]

New automatic coupler for main line railways,

by Ad.-M. Hug, M.I.Mech.E., Consulting Engineer, Thalwil-Zurich, (Switzerland).

Résumé. — Detailed description, with drawings and photographs, also results of trials in railway operation, of a new patented automatic coupler for main line railways, developed 1954 by an important Swiss industrial Company as the result of various demands, particularly from the Irish Railways (Córas Iompair Éireann) which has amongst other gauge lines, 3 000 km (1 900 miles) of broad gauge lines. Dimensions and weights; wise of working; behaviour.

This new automatic coupler — which we will designate in this article by the sign of its origin +GF+ — has been tested for nearly two years (1956/57) on the C. I. É. Railways in Ireland (broad gauge 5′3″ = 1 580 mm) on two four wheeled wagons for carrying cattle and four eight wheeled main line coaches, used in either diesel rakes or the express trains.

The author, who as a railwayman was one of the first to introduce automatic couplers on a main railway system (1) as far back as 1922, on reversible suburban motor rakes, has had the opportunity of following the development and trials of the new +GF+ coupler, both in the factory and in service (Dublin-Inchicore).

(1) On the Djakarta suburban lines (then Batavia) for which he had to order and put into service, as one of the Assistants of the Chief Mechanical Engineer, electric rolling stock (reversible electric motor units and trailers, which could be coupled up in various combinations of « motor unit-trailer ») of the Indonesian State Railways « Djawatan Kereta Api » DKA (at that time : « Staatsspoorwegen in Ned. Indië » SS). — See *Bulletin of the Belgian Society of Engineers and Industrials*, Brussels, February-March 1929, pp. 123-158 with 31 figures, Ad.-M. Hug.

Before describing the new +GF+ automatic coupler, we would like to remind readers about the UIC « specifications » for automatic couplers for main railway systems. There are three stages for their introduction :

— *first stage :* Transition type of automatic coupler for adaptation on the existing standard coupling, retaining the side buffers and drawgear;

— *second stage :* Central automatic coupler also acting as buffer, the front ends of the coach or wagon frames having been strengthened in view of the traction and buffing stresses; the side buffers are still retained;

— *third stage :* Central automatic coupler including the buffing and draw gear, without side buffers.

The new +GF+ coupler meets these UIC specifications : we have shown in figures 1 to 9, also 13, the first stage (and second stage) coupler and in figure 14, the final coupler without side buffers.

Passing to description of the +GF+ coupler and its working, we will deal

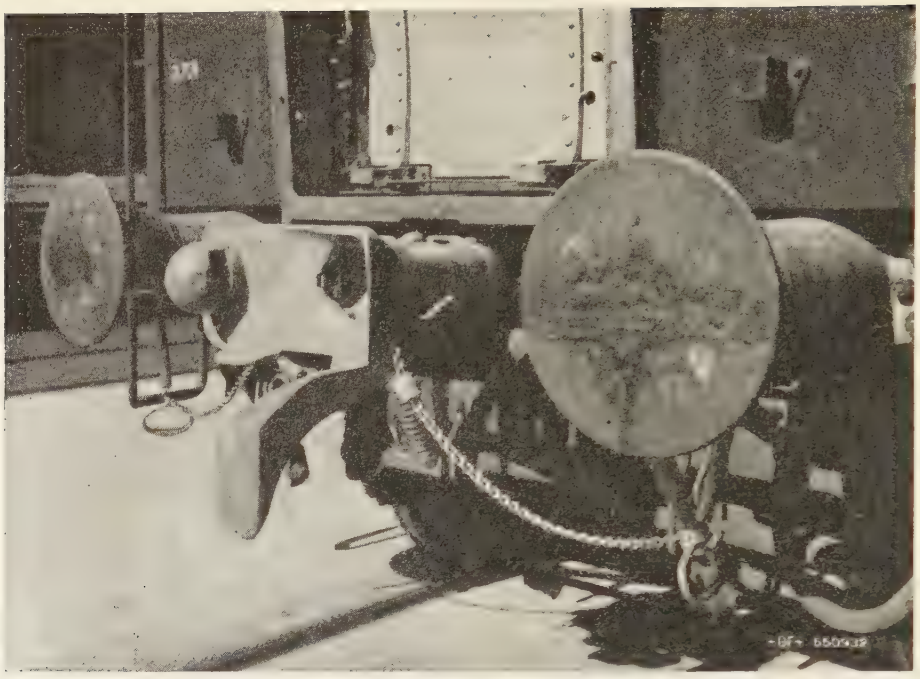


Photo +GF+

Fig. 1. — Central automatic coupler head (shown as transition coupler with buffers) mounted for a factory test on a CFF main line coach (compare figures 2, 5, 9 and 14).

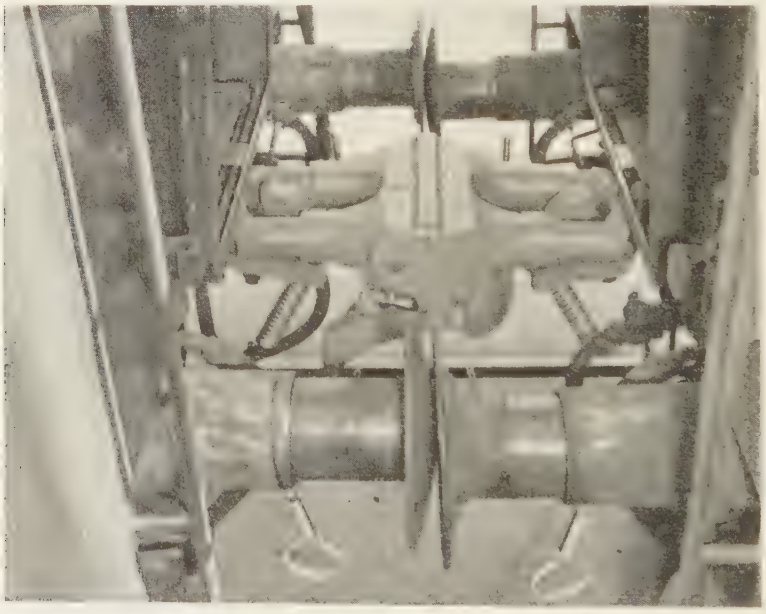


Photo +GF+

Fig. 2. — Same coupler as in fig. 1 coupling two CFF main line coaches; the buffers are touching, the usual drawbar couplings are hooked up on either side and the bellows folded back.

first with the 20 figures illustrating this article.

The photographs figures 1 to 4 show the +GF+ coupler fitted, for factory coupling trials, to main line rolling stock

operations with this coupler. It should be noted that the principal dimensions are given in figures 5 and 14.

Figure 13 gives the area in which can be done coupling with the maximum

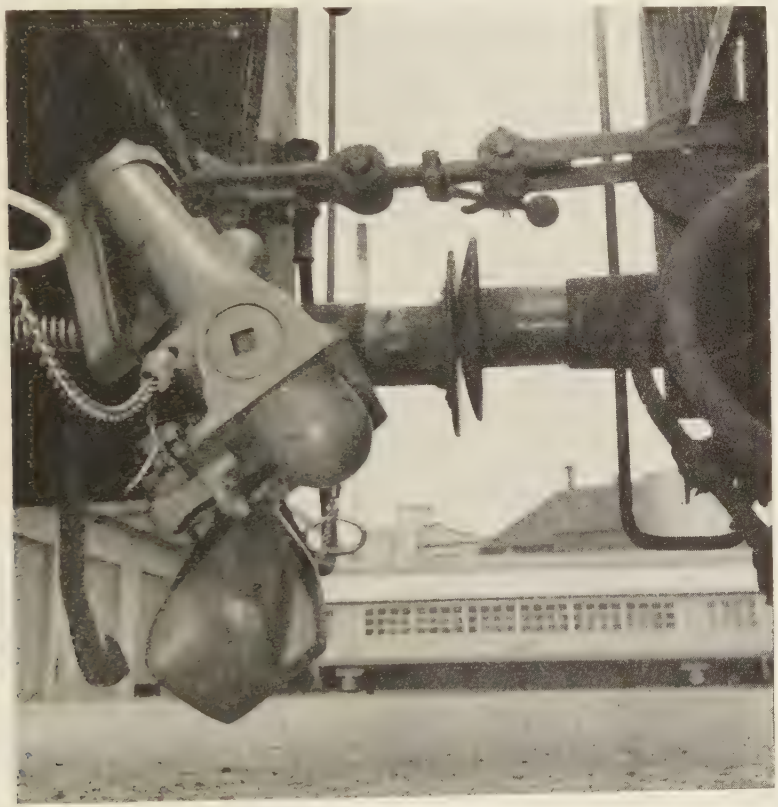


Photo +GF+

Fig. 3. — Same automatic coupler head as in fig. 1, but lowered, the right hand coach (coupled up to the left hand coach by the usual draw bar coupling) not being fitted with an automatic coupler.

of the Swiss Federal Railways SBB-CFF-FFS; the diagrams, figures 5 to 9, show the transition coupler (various views and positions); the sections figures 10 to 12 show the coupling up and uncoupling

horizontal and vertical off-sets, according to the suggestions of the UIC, for the transition coupler (stages 1 and 2), but also corresponding to UIC stage 3 (see above); vertically the +GF+ coupler

meets the UIC requirements, and horizontally it exceeds them by 70% on the dimensions.

Figure 14 shows the final coupler with the buffing and draw gear parts, without buffers, according to third stage of the above UIC standards.

Finally the photographs reproduced in figures 15 to 20 show applications and trials on the C. I. É. System.

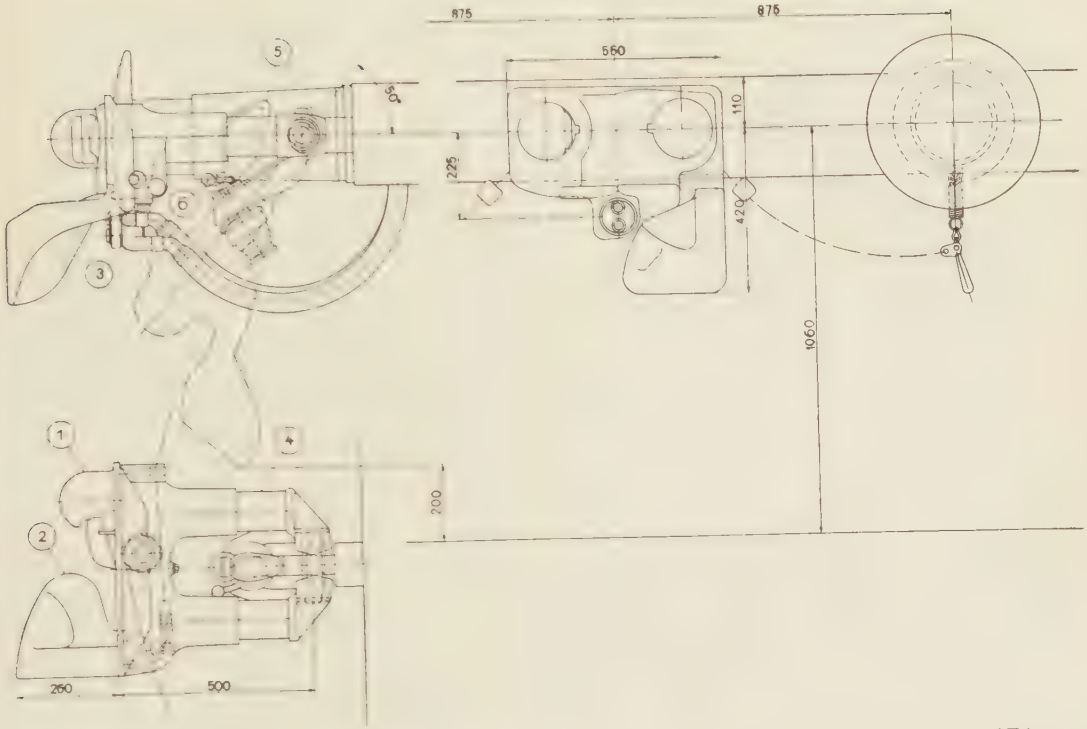
Working of the +GF+ automatic coupler for Railways.

The transition coupler (UIC stages 1 and 2) consists of the following parts (see fig. 5): hemispherical coupling clutch-head (1) with pick-up or gathering slide (2) and pneumatic shut off valve (3), double (or forked) plunger (4) and drawhook cap for holding up the coupler



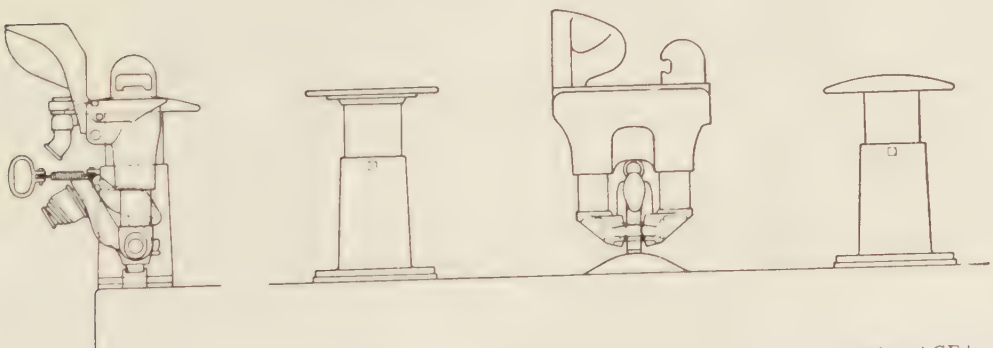
Photo +GF+

Fig. 4. — Same coupler as in fig. 2, but with intercommunication bellows closed between the two coaches; to the extreme left and right can be seen in the foreground the coupling for the electric heating cable.



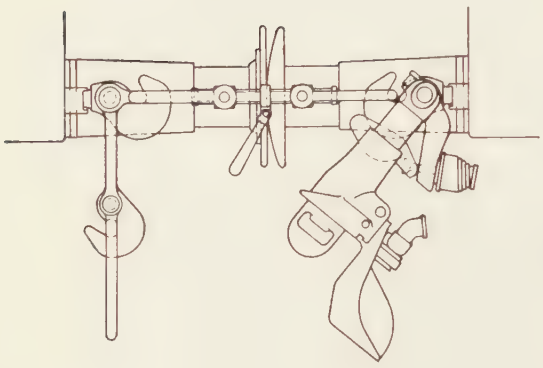
Design +GF+

Fig. 5. — Elevation, front view and plan, with dimensions, of the coupler head (compare fig. 1); transition assembly with buffers; the dotted line shows the coupler head lowered as in fig. 3 (the figures in parenthesis refer to the parts as indicated in the text).



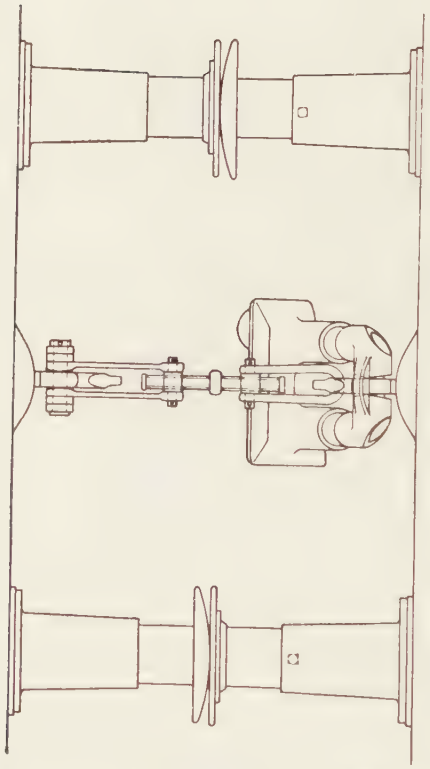
Design +GF+

Fig. 6. — View in plan and elevation of the coupler head, corresponding to fig. 1, with buffers.



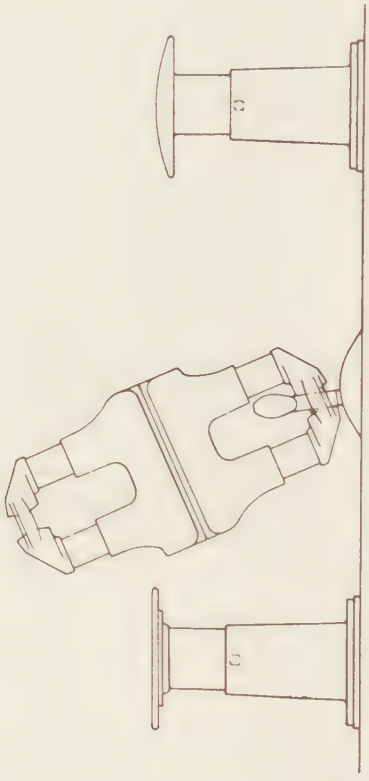
head (5) with the drawhook cap release lever (6).

The working of the automatic coupler is as follows (fig. 10 to 12) : the hemispherical clutch-head has a locking drawbolt *a* (fig. 10, compare also fig. 5 and 6) with a triangular shaped guiding opening *b* and a nose *c* chamfered towards the front. A stop pawl *d* is inserted in the locking drawbolt *a*; this stop pawl can turn around a pin *e* and is held in position by a compression spring *f*.



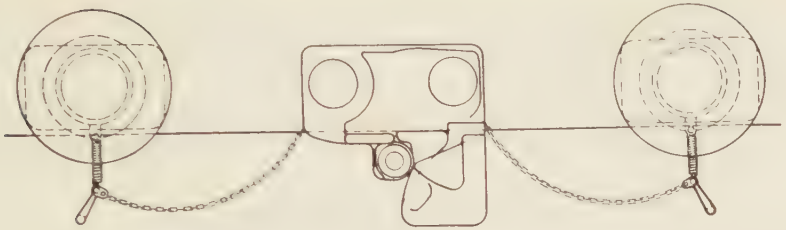
Design +GF+

Fig. 7. — Elevation and plan corresponding to fig. 3, automatic coupler head lowered, coaches connected by screw coupling to draw bar, with buffers.



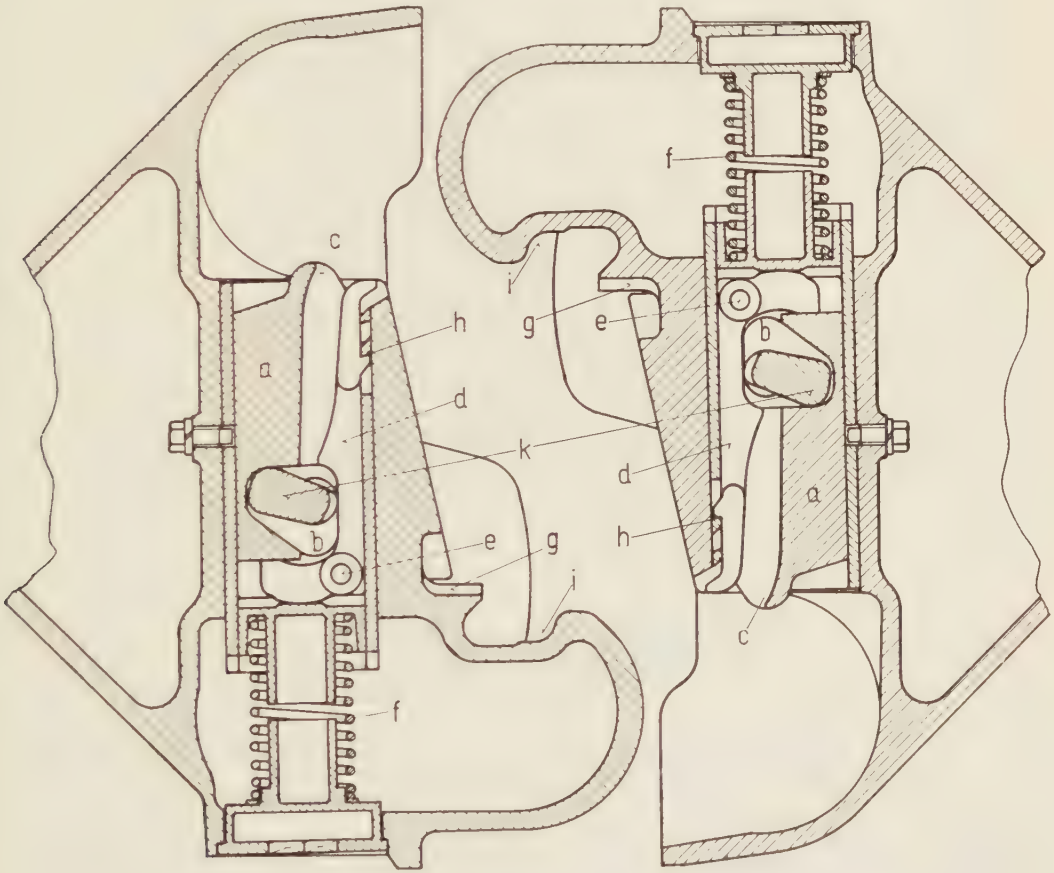
Design +GF+

Fig. 8. — Plan of transition automatic coupler; the two coupler heads are coupled up here in the position of the maximum angle of horizontal displacement.



Design +GF+

Fig. 9. — Simplified view from the front, of the transition coupler (compare fig. 5 and 6) with the uncoupling chains fastened under the buffers.



Design +GF+

Fig. 10. — Vertical section of the coupler head according to fig. 1 to 9, showing the working of the coupler which is here ready to be coupled up. The letters are explained in the text.

When coupling up (fig. 11), the stop pawl *d* is pushed from the stop notch *h* in which it rests into the raised part of the other head *g* so that the locking drawbolt *a* is pushed inwards by the pressure of the spring *f* and in its turn pushes the nose *c* into the hooked recess *i* on the hemispherical clutch-head. The eccentric pin *k* of the vertical release shaft is then turned into the locking position and locks the hemispherical clutch-heads. This locking therefore is a twofold one (double lock).

Uncoupling (fig. 12) is effected by a sharp pull on both the chain grips of the two coupler heads, which pulls back the eccentric pin *k* so that the nose *c* of the locking drawbolt *a* comes out of the hooked recess *i*. The stop pawl *d* is then pushed above the projection *g* and

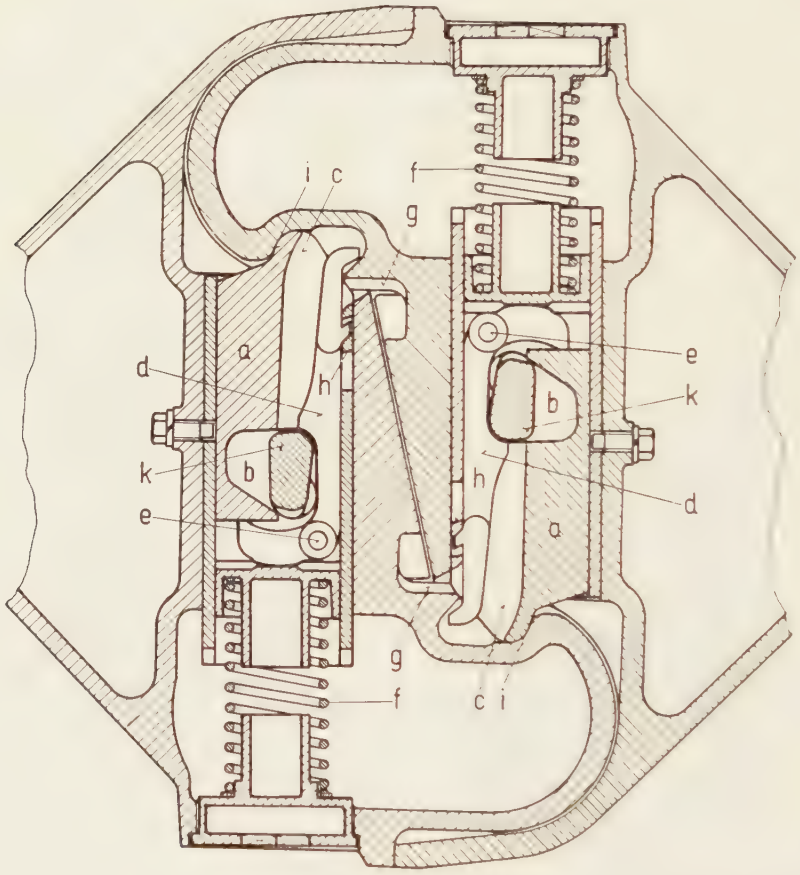
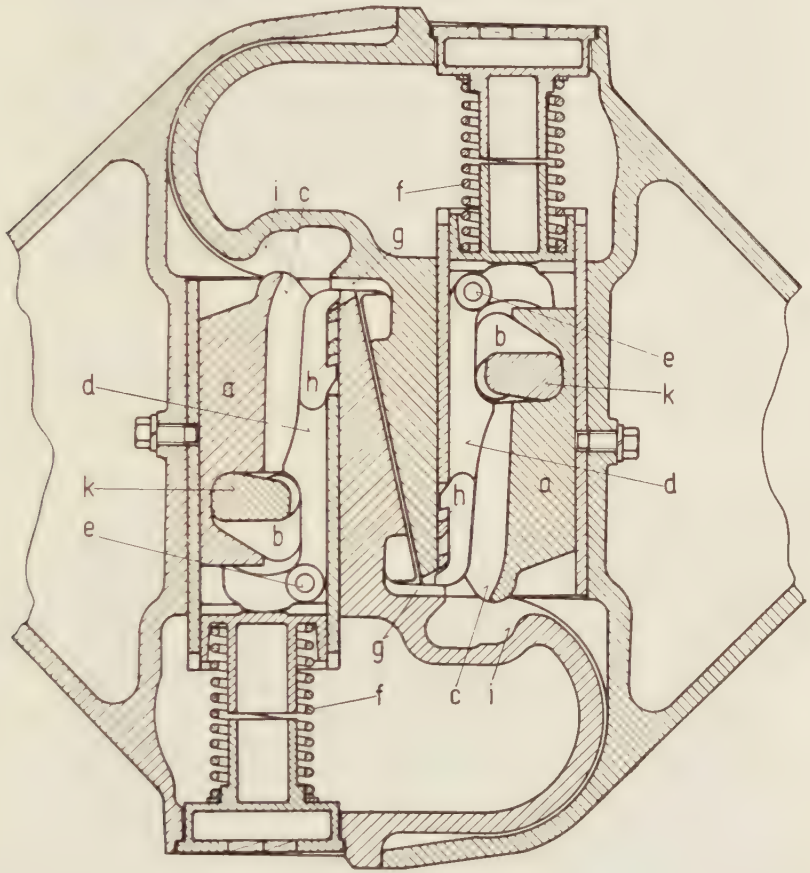


Fig. 11. — Same vertical section as in fig. 10, coupling up being completed (explanation in the text). Design +GF+

slides, after the uncoupling chains have been pulled, till it comes to the stop notch *h*. The coupling heads are then ready to be coupled up again.

grip chain nearest the coupler head as this locks the draw bolt.

The field in which coupling takes place (guiding of the two coupler heads

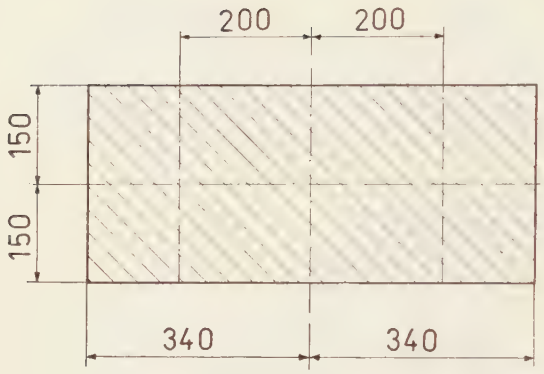


Design +GF+

Fig. 12. — Again, same section as fig. 10 and 11, the coupler being released to separate the two coaches (or wagons).

Fly shunting of vehicles when making up trains, can be done as soon as the so-called « shunting » pin has been housed in the link of the coupler hand-

towards each other), which is indicated in figure 13 (and in reality is not a rectangle but an ellipse) has been increased, horizontally at least, by 70% relatively



Design +GF+

Fig. 13. — Angular field in which coupling will take place (vertical and horizontal) of the new +GF+ automatic coupler; the dimensions 200 + 200 (horizontal) and 150 + 150 (vertical) are those laid down by the UIC; the dimensions at bottom, 340 + 340, show the horizontal range of action of this coupler.

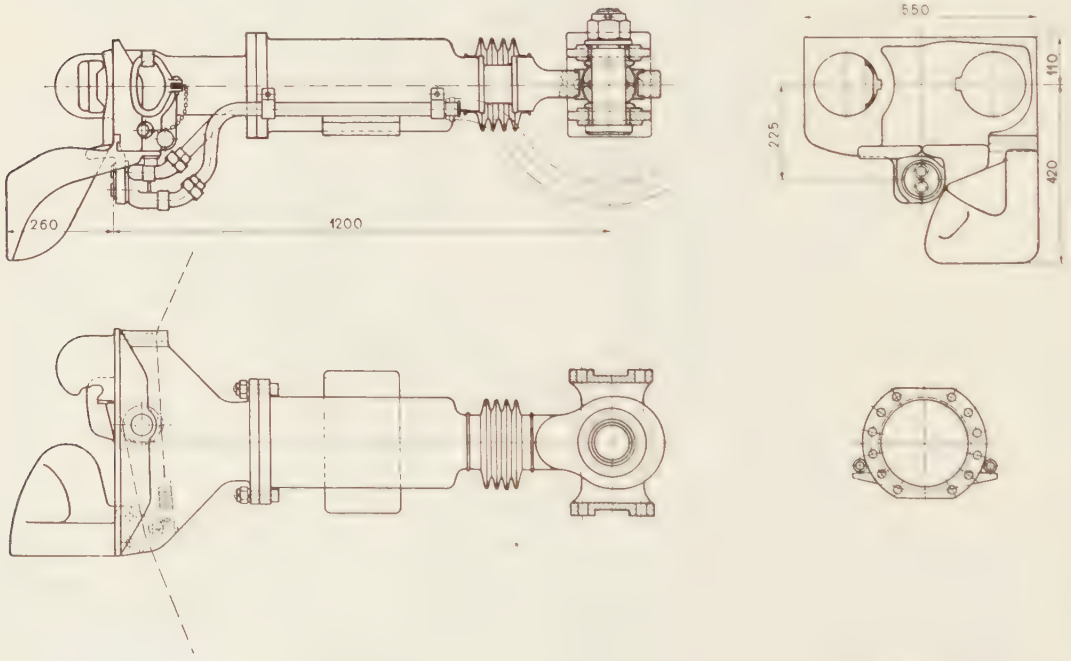
to that prescribed by the UIC, thanks to the use of the specially shaped pick-up or gathering slide which, in the position when the coupler head has been dropped down, is still with the usual buffer centre height of 1 060 mm ($41^{3}/_{4}''$), 20 cm ($7^{7}/_{8}''$) above rail level (fig. 5).

Under the coupler head, cast in the block, there is a special bracket to take the pneumatic valves, either one, 2″ in diameter in the case of the vacuum brake, or two (2 × 1″ diameter) for the compressed air brake.

The weights are as follows :

— coupler head with valves for the brake pipes, corresponding to UIC first stage : 146 kg (322 lbs);

— complete coupler with buffing-draw



Design +GF+

Fig. 14. — Complete automatic coupler, final type, with buffing and draw gear and the two valves for the compressed air brake (without buffers, compare fig. 5), in elevation (pivot in section), front view and plan; the lower drawing on the right shows the joint between the coupler head and the buffing draw gear components.



Photo Ing. Ad.-M. Hug.

Fig. 15. — View of two four wheeled wagons used to carry cattle, linked together (as a single operating unit, according to the inscription visible under the series number, under the distinctive sign of the C.I.É. system) by transition type +GF+ automatic coupler; the buffers no longer touch.



Photo Ing. Ad.-M. Hug.

Fig. 16. — View of two main line eight wheeled coaches of the C.I.É. Rlys., connected together by transition type +GF+ automatic coupler; intercommunication bellows closed; as in fig. 15 the buffers no longer touch.

gear, according to second and third UIC stages :

a) for 32 t of final compression : between 200 and 250 kg (approx. 450 and 550 lbs) including the pneumatic connections *and also the electric contacts* for multiple unit rakes;

couplings for more than 40 years, on the one hand for main line railways and on the other hand, especially for light railways and tramways; these factories invented amongst others the automatic coupling (or semi-automatic in the case of tramways) used for many decades on



Photo Ing. Ad.-M. Hug.

Fig. 17. — The two coaches shown in fig. 16, just before being coupled up; it will be noted (also by the shadow on the track) how much they are off-set laterally on a curve of 100 m radius (5 chains); the handgrips of the uncoupling chains can be clearly seen.

b) for 55 t of final compression : between 250 and 300 kg (approx. 550 and 650 lbs), also including the pneumatic and electric connections.

The weights under *a*) and *b*) depend upon method of fitting the terminal boxes for the electric cables.

We might mention that the makers of this coupling (George Fischer Steelworks +GF+) have been making automatic

most of the large tramway systems in Switzerland, as well as a rather stronger pattern used on several metre gauge local railways (2) in particular the Brunig line

(2) See *Économie et Technique des Transports*, Zurich, no. 10-12 of 1952, part « H », Automatic couplers for secondary railways and tramways », 4 p., 7 fig., in a series of articles (German and French) : « De quelques particularités qui influencent l'économie de l'exploitation de chemins de fer », during 1952, with a total of 38 figures, Ad.M. HUG.



Photo Ing. Ad.-M. Hug.

Fig. 18. — Same view as in fig. 17, but taken closer, at the moment of coupling up; the off-set is still more accentuated, also in height.

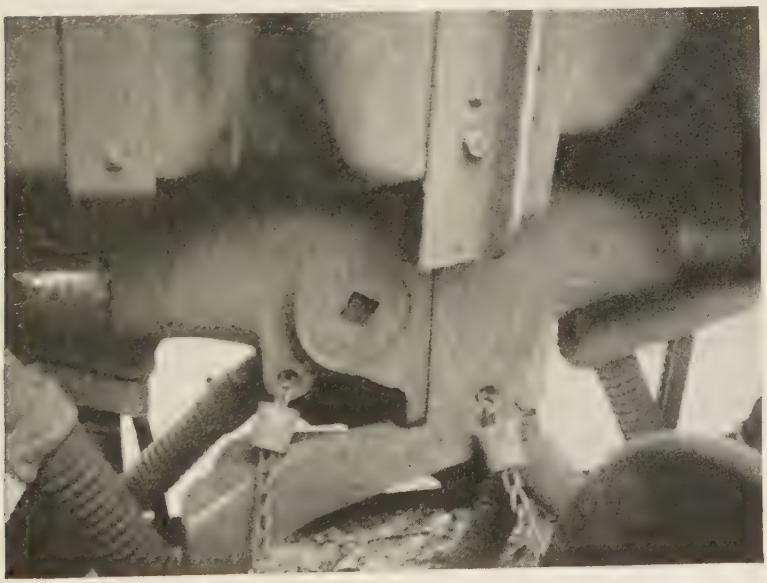


Photo Ing. Ad.-M. Hug.

Fig. 19. — The coupling up of the two coaches shown in fig. 17 and 18, by automatic transition coupler.

(from Lucerne to Interlaken) of the CFF, the electric line from Soleure to Berne SZB, the Lausanne - Échallens - Bercher and Lausanne-Moudon lines in the Canton of Vaud, Zürich - Egg - Esslingen (Forch Railway), Schwander - Elm (Glaris), etc.

head. These off-sets naturally had to be prepared artificially by moving the front ends of the coaches or wagons sideways or lifting them up, insofar as such off-sets could not be obtained on small radius curves of hilly lines.

The coupler heads always slide



Photo Ing. Ad.-M. Hug.

Fig. 20. — Coupling up on a curve of 100 m (5 chains) radius in the C.I.É. Works at Inchicore; the lowered coupling head on the facing coach can be seen.

Coupling up trials in the factory.

We have given (also in the legend for fig. 13) the maximum off-sets for which coupling up is effective, namely up to 34 cm ($13^3/_8$″) transversely off-set on either side of the centre line of the track, and vertically up to 15 cm (nearly 6″) above and below, on either side of the horizontal plane through the axis of the buffers, 1 060 mm ($41^3/_4$″) above rail

smoothly and without apparent resistance into one another, even on the smallest radius curves and with the greatest differences in level. It is remarkable to observe that damage cannot occur with this +GF+ coupler if at the moment of coming together, one or other of the heads for some reason is not in the coupling up position; in fact when one hemispherical clutch-head penetrates into the corresponding hemispherical recess,

the stop pawl *d* in such a case is simply pushed back with the locking drawbolt *a* and if the thrust of the hemispherical clutch-head continues, comes into the hooked recess *i*.

Application in railway working.

As a result of various requests, particularly from the Chief Mechanical Engineer of the Irish Railways, Córas Iompair Éireann, C. I. É., Mr. O. V. S. Bulleid ([3]), the +GF+ Steelworks invented in 1954 the new automatic coupler dealt with in this article. After various trials in the factory, first of all with metre gauge wagons, then with CFF main line coaches, it was decided to equip several coaches and wagons of the C. I. É. with this coupler. These trials had lasted nearly two years by the end of 1957.

Because of the very favourable results obtained — which the author was able to see for himself in 1957 — the C. I. É. Railways decided to fit a first series of 30 cattle wagons, similar to those shown in figure 15, with this coupler during 1958.

During the severe trials in service in Ireland during these two years these +GF+ couplers have not shown any signs of wear. The two cattle wagons shown in figure 15, as indicated in the legend, were connected for the trials in service into one unit which remain coupled up, but with carefully supervised orders to uncouple and couple up several times every time they ran through certain stations or yards. In spite of the heavy accumulation of dung over them, as these couplers were intentionally never cleaned in service, there was never any case of failure.

On the other hand, trials have shown, particularly in the case of *coaches* coupled up by the +GF+ coupler, that uncoupling always takes place without any trouble, even under a heavy tractive effort.

Most of the coupling and uncoupling trials were made with rolling stock in service without any special preparation; a great part of these coupling up trials were made on the smallest radius curve available (5 chains = approx. 100 m), as can be seen in figures 18 to 20.

The author is of the opinion, according to his own personal observations and experience, that this new +GF+ coupler fully meets railway operating requirements in every respect.

To conclude it should be noted that the photographs shown in figures 1 to 4 as well as the drawings figures 5 to 14 were kindly prepared and put at our disposal by the Schaffhausen +GF+ Steelworks. The photographs shown in the six figures 15 to 20 are not all very sharp but this can be explained by the fact that they were taken by the author with small pocket camera and have been enlarged 200 times approximately.

(3) Formerly Assistant Chief Mechanical Engineer of the old LNER, then Chief Mechanical Engineer of the Southern Railway (SR), up to the amalgamation of the British Railways, BR.

[385 (06 .111]

OFFICIAL INFORMATION

ISSUED BY THE

PERMANENT COMMISSION

OF THE

International Railway Congress Association.

Meeting of the Permanent Commission, held on the 2nd June 1958.

The Permanent Commission of the International Railway Congress Association held a meeting on June 2, 1958, at the Wellington Hotel, at Ostend.

* * *

Mr. De Vos, *President*, opening the session addressed a warm welcome to the numerous personalities present. Then, he requested the Assembly to approve the Minutes of the last Meeting of the 7th December 1957.

The President recalled that since the last session, two members of the Permanent Commission were deceased : Mr. René Claudon, Vice-President of the Administrative Board of the French National Railways and Lt. Col. G. R. S. Wilson, Chief Inspecting Officer of Railways, Ministry of Transport and Civil Aviation (Great Britain). He paid a tribute to the memory of these eminent personalities pointing out the interest they have always shown to the works of the Association.

The Assembly united in this manifestation of sympathy.

* * *

Mr. Ghilain, *General Secretary*, reported to the Meeting the modifications in the constitution of the Permanent Commission since its last session, as well as the steps taken to fill the vacant mandates.

The Assembly approved the nomination of the following personalities as members of the Permanent Commission.

Mr. Mohamed Halim El-Rashid, General Manager of the Railways of the Egyptian Republic, to replace Mr. Gamal el Din Badawy Hamdy, called to other functions;

Mr. Mohamed Afifi, Deputy General Manager of the Railways of the Egyptian Republic to replace Mr. Moussa Arafa, who has taken other functions;

Brigadier C. A. Langley, Chief Inspecting Officer of Railways, Ministry of Transport and Civil Aviation (Great Britain), to replace Lt. Col. G. R. S. Wilson;

Mr. Erkki Tauno Aalto, General Manager of the Finnish State Railways, to replace Mr. F. L. Leitinen, retired.

The GENERAL SECRETARY reported also to the Meeting that Mr. L. ARMAND, former President of the Administrative Board of the French National Railways, has been called to other functions and that Messrs. Ch. BOYAUX, General Manager and A. PORCHEZ, Deputy General Manager of the S.N.C.F., are retired.

Five members of the Permanent Commission have requested that according to Art. 6 of the Rules and Regulations, the mandates of Messrs. ARMAND, BOYAUX and PORCHEZ should be maintained up to the next Congress.

— The Assembly agreed to this proposal.

Mr. GHILAIN mentioned also that it is traditional to increase the number of seats on the Permanent Commission in favour of the country inviting the Congress. Therefore, it was proposed to submit to the Plenary Meeting the allocation of two new mandates in favour of Spain. *(Approved.)*

* * *

According to Art. 6 of the Rules and Regulations, one third of the members of the Permanent Commission shall retire at each Congress and shall be eligible for re-election.

This stipulation is applicable to seventeen members and, as in the past, it has been decided to ask them if they wish the renewal of their mandate expiring at the 17th Session. The renewal of these mandates will be submitted to a plenary meeting in Madrid.

* * *

The GENERAL SECRETARY gave information to the Meeting concerning the preparatory work of the Madrid Congress. The Secretariat has now all the reports in its possession and the necessary steps have been taken for their publication so that the delegates will receive them before the Madrid Congress. In addition, several reporter's meetings have taken place in order to make quite clear the draft of the text of the conclusions to be submitted by the special Reporters.

Mr. GARCIA LOMAS, *Vice-President of the Administrative Board of the RENFE* and *President of the Executive Organizing Committee*, reported on the arrangements already made by the Local Organizing Commission. These arrangements refer in particular to the printing of the documents for the delegates, the choice of the rooms for the meetings and the offices of the Congress and the publication of the Congress Daily Journal.

Mr. GARCIA LOMAS expressed the hope that His Exc. General FRANCO will accept the Presidency of honour of the Congress. The Presidency of the Session will be assumed by Mr. PLANA, Under-Secretary of State for Public Works and President of the Administrative Board of the RENFE.

Finally, Mr. GARCIA LOMAS assured that all will be done so that the Madrid Congress will be as successful as the previous Sessions.

On behalf of the Assembly, the PRESIDENT expressed his thanks to Mr. GARCIA LOMAS and his assistants for the efforts made for the success of the Congress.

The GENERAL SECRETARY then gave further information relative to the travel-

ling facilities granted to the Delegates and the accompanying ladies for their journey to Madrid and in Spain. The Secretariat of the Association will forward in due course to the delegates, a *Vade-Mecum* containing the Rules and Regulations of the Association, the list of questions to be discussed, the programme of the work, receptions, excursions, etc.

* * *

Mr. Ghilain informed the Meeting of the names of the personalities chosen for the functions of Presidents of the five Sections, as well as those of the Special Reporters, whose task is to sum up the various reports on a same Question in view of the discussions at the Madrid Congress.

* * *

Mr. Ghilain acquainted the Meeting with a proposal of the Executive Committee to hold in Brussels in 1960 an Enlarged Meeting of the Permanent Commission to commemorate the 75th anniversary of the Association.

The arrangements for the organisation of this Session will be decided at the Madrid Congress. It was suggested already now to put on the agenda the study of three questions to be chosen by the Permanent Commission. *(Approved.)*

* * *

The final account of the receipts and expenditures relative to the financial year 1957 was then approved by the Assembly.

* * *

The Assembly then heard about the changes in membership since the meeting of the 7th December 1957.

As new members, mention must be made of the *Ghana State Railways* (West Africa), with a mileage of 885 km (550 miles); in addition, *the Cameroons Railways and the Togo Railways* included previously in the " Chemins de fer de l'A.O.F. et de l'Afrique Equatoriale Française ", respectively, have requested their membership as separate adherents.

The International Railway Congress Association includes therefore at present 34 Governments, 10 Organisations and 104 Railway Administrations with a total mileage of 602 727 km (374 517 miles)

* * *

The Meeting ended after the examination of various items concerning the activities of the Association, in particular in connection with the " Bulletin Sales " and " Advertising " Departments.

The General Secretary, (s.) P. Ghilain. *The President,* (s.) M. De Vos.

List of Members of the Permanent Commission

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

(2nd JUNE 1958)

President :

M. **De Vos** (2), Directeur Général de la Société Nationale des Chemins de fer belges; 19, rue du Beau-Site, Bruxelles.

Vice-presidents :

J. **Goursat** (3), Directeur de la Région du Nord de la Société Nationale des Chemins de fer français; 18, rue de Dunkerque, Paris (X^{e});

M. **Crem** (3), Directeur du Service de l'Exploitation de la Société Nationale des Chemins de fer belges; 17, rue de Louvain, Bruxelles.

Members of the Executive Committee :

E. **Dorges** (2), Secrétaire Général Honoraire aux Travaux Publics et aux Transports, Délégué Général aux Affaires Internationales du Ministére des Travaux Publics, des Transports et du Tourisme; 244, boulevard Saint-Germain, Paris;

Sir John **Benstead** (3), Deputy Chairman of the British Transport Commission; 222, Marylebone Road, London, N.W.1;

Sir Gilmour **Jenkins** (1), Permanent Secretary, Ministry of Transport and Civil Aviation (Great Britain); Berkeley Square House, Berkeley Square, London, W. 1.

Ex-presidents of session, members ex-officio :

D^{r} Ing. G. **di Raimondo**, Directeur Général des Chemins de fer de l'Etat .italien (*retired*); Rome;

Ibrahim Fahmy **Kerim**; Le Caire;

D^{r} W. **Meile**, ancien Président de la Direction générale des Chemins de fer fédéraux suisses; Brügglerweg, 11, Berne;

General Sir Brian **Robertson**, Bart., G.C.B., G.B.E., K.C.M.G., K.C.V.O., D.S.O., M.C., Chairman, British Transport Commission, 222, Marylebone Road, London, N.W.1.

Members :

E.T. **Aalto** (2), Directeur Général des Chemins de fer de l'Etat de Finlande; Helsinki;

Mohamed **Afifi** (2), Directeur Général Adjoint des Chemins de fer de la République d'Egypte; Le Caire.

L. **Armand**(2), ancien Président du Conseil d'Administration de la Société Nationale des Chemins de fer français; 88, rue Saint-Lazare, Paris (IX^{e});

D^{r} Ing. A. **Attisani** (2), Chef du Service du Matériel et de la Traction des Chemins de fer italiens de l'Etat (*retired*); Florence;

Abdel Moneim **Azmy** (2), Sous-Secrétaire d'Etat au Ministère des Communications d'Egypte; Le Caire;

Sir John **Benstead** (already named);

R. **Besnard** (1), Chef de Service adjoint au Directeur général des Chemins de fer et des Transports, Ministère des Travaux publics, des Transports et du Tourisme; 244, boulevard Saint-Germain, Paris;

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Ch. **Boyaux** (1), Directeur Général Honoraire de la Société Nationale des Chemins de fer français; 88, rue Saint-Lazare, Paris (IX^{e});

Dipl.-Ing. A. **Brill** (2), Ministerialdirektor, Leiter der Maschinentechnischen- und Beschaffungsplanungsabteilung der Hauptverwaltung der Deutschen Bundesbahn; Friedrich-Ebert-Anlage, 43-45, Frankfurt (Main);

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(2) Retires at the 18th session.
(3) Retires at the 19th session.

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T.C. **Courtney** (2), Chairman of the Coras Iompair Eireann; Kingsbridge Station, Dublin;

M. **Crem** (already named);

Csanadi (3), Directeur Général des Chemins de fer de l'Etat hongrois; Budapest;

Dr Ing. A. **Cuttica** (2), Directeur Général Adjoint et Conseiller d'Administration des Chemins de fer italiens de l'Etat; Rome;

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J. **de Aguinaga** (1), Directeur Général Adjoint du Réseau National des Chemins de fer espagnols; Madrid;

F.Q. **den Hollander** (3), Président des Chemins de fer néerlandais, S.A.; Utrecht;

M. **De Vos** (already named);

M. **Dias Trigo** (3), Directeur des Services d'Exploitation et du Matériel de la Direction des Transports terrestres au Ministère des Travaux publics et des Communications du Portugal; Lisbonne;

G.H. **Dijkmans van Gunst** (2), Conseiller au Ministère des Transports et du Waterstaat; La Haye;

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E. **Dorges** (already named);

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Sir Gilmour **Jenkins** (already named);

Ibrahim Fahmy **Kerim** (already named);

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R. **Kunz** (1), Directeur de l'Office fédéral des transports;Berne;

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(2) Retires at the 18th session.
(3) Retires at the 19th session.

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A. **Plana** (2), Sous-Secrétaire d'Etat aux Travaux Publics et Président du Conseil d'Administration du Réseau National des Chemins de fer espagnols; Madrid;

A. **Porchez** (1), Directeur Général Adjoint Honoraire de la Société Nationale des Chemins de fer français; 88, rue Saint-Lazare, Paris (IX^{e});

General Sir Brian **Robertson** (already named);

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Dr M. **Schantl** (2), Directeur Général des Chemins de fer fédéraux autrichiens; 9, Elisabethstrasse, Vienne I;

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H.E. **Simpson** (3), President, Baltimore and Ohio Railroad Company; Baltimore, Md.:

P.E.N. **Skov** (2), Directeur Général des Chemins de fer de l'Etat danois; 40, Sölvgade, Copenhague, K;

H.E. **Stokke** (1), Directeur Général des Chemins de fer de l'Etat norvégien; Oslo;

Ing. J. **Švagel** (1), Directeur de l'Institut Ferroviaire de la Direction Générale des Chemins de fer Yougoslaves; Belgrade;

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F. Perez **Villamil** (1), Directeur Adjoint du Réseau National des Chemins de fer espagnols; Madrid;

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Dr. Ing. W. **Wyrzykowski** (3), Vice-Directeur de l'Institut Scientifique des Essais et des Recherches Ferroviaires des Chemins de fer de l'Etat Polonais; Varsovie;

N... (1) Argentine.
N... (2) Argentine.
N... (1) Belgium.
N... (1) Bulgaria.
N... (1) China.
N... (3) U. S. A.
N... (2) France.
N... (3) Great Britain.
N... (2) Great Britain.
N... (3) India.
N... (1) Rumania.
N... (1) Switzerland.

Honorary President : F.H. **Delory**, Directeur Général honoraire de la Société Nationale des Chemins de fer belges; 2, avenue Rév. Clément, Rixensart.

Members of Honour : O.V.S. **Bulleid**, former Chief Mechanical Engineer, Coras Iompair Eireann; and former Chief Mechanical Engineer, Southern Region, British Railways; St. Anthony's Close, Belstone, Devon;

R. **da Costa Couvreur**, ancien Président du Conseil supérieur des Travaux publics au Ministère des Travaux publics et des Communications du Portugal; Alameda das Linhas de Torres, 149, Lisbonne;

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Ranald J. **Harvey**, Consulting Engineer, 34, Victoria Street, Westminster, London, S.W.1.

The Rt. Hon. Lord **Hurcomb**, G.C.B., K.B.E., Chairman, British Transport Commission 1947-53; 47, Campden Hill Court, Campden Hill Road, Kensington, London W$_{8}$ 8;

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(1) Retires at the 17th session.
(2) Retires at the 18th session.
(3) Retires at the 19th session.

SECRETARY'S OFFICE : 19, rue du Beau-Site, Brussels.

General Secretary : **P. Ghilain.**

MONTHLY BIBLIOGRAPHY OF RAILWAYS[1]

PUBLISHED UNDER THE SUPERVISION OF

P. GHILAIN,

General Secretary of the Permanent Commission of the International Railway Congress Association.

(AUGUST 1958)

[016. 385 (02]

I. — BOOKS.

In French.

1958 385 (06. 4 (493)

Les Chemins de fer au rendez-vous de Bruxelles.

Bruxelles, édité par le Centre d'Information des Chemins de fer Européens (C.I.C.E.), Commission spéciale, 17 rue de Louvain. Une brochure (20 × 26 cm) de 80 pages, abondamment illustrée.

1958 385 (08 (493)

SOCIÉTÉ NATIONALE DES CHEMINS DE FER VICINAUX.

Rapport présentés par le Conseil d'Administration et par le Comité de Surveillance. Soixante-treizième exercice social (1957).

Bruxelles : Imprimerie Graphica, 54, rue Auguste Lambiotte. Une brochure (22.5 × 30.5 cm) de 118 pages, avec de nombreux tableaux et illustrations.

1958 624

ZAYTZEFF (S.).

Calcul des constructions hyperstatiques par les méthodes de relaxation. 3e édition.

Paris, Dunod, éditeur. Un volume (16 × 25 cm) de 330 pages avec 222 figures. (Prix : 2 300 fr. fr.)

In German.

1958 621 .87

AUMUND (H.) & MECHTOLD (F.).

Hebe-und Förderanlagen. IV. neubearbeitete und erweiterte Auflage.

Berlin, Springer-Verlag. 309 Seiten mit 312 Abbildungen. (Preis : Gln. DM 42.—.)

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PREDÖHL (A.).

Verkehrspolitik.

Göttingen, Zürich, Verlag Vandenhoeck & Ruprecht. 360 Seiten. (Preis, Leinen : DM 26.80.)

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Betonfibel, Ratgeber für die Herstellung von Beton und Betonsteinerzeugnissen. 2. Auflage.

Berlin und Wiesbaden, Bauverlag GmbH. 280 Seiten mit 68 Abbildungen, 48 Tabellen und Diagramme. (Preis : kart. DM 6.80.)

In English.

1958 621 .132 .1 (42)

NOCK (O. S.)

The Great Northern Railway.

Edited by Ian Allan Limited. Craven House. Hampton Court, Surrey.

One volume (8 1/2 in. × 6 1/4 in.) 192 pp. Illustrated. (Price 30 s.)

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Bristish Transport policy.

One volume (7 1/2 × 5 in.) of 164 pages.

London : Clarendon Press; Oxford University Press, Amen House, Warwick Square, E.C. 4. (Price : 15 s.)

1958 62 (01

SIDEBOTTOM (O.M.) and CLARK (M.E.).

Theoretical and experimental analysis of members loaded eccentrically and inelastically.

University of Illinois engineering experiment station bulletin No. 447

Volume 55, number 51, March 1958. Published by the University of Illinois.

Office of publication. 2 Administration Building (East), Urbana, Ill. (Price : One dollar).

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The Locomotives of the Great Western Railway.

Part V : Six-coupled tank engines.

One volume (8 × 6 in.) of 96 pages + 38 pages with plates.

Published by the Railway Correspondence & Travel Society and obtainable from its Hon. Publications Officer, Mr. T. J. Edgington, at 57. Heathfield Road, Kings Heath, Birmingham 14. — Paper covers. (Price : 15 s.)

1958 62 (01

WORLEY (W. J.).

Inelastic behavior of aluminum alloy I-beams with web cutouts.

University of Illinois engineering experiment station bulletin No. 448. Volume 55, number 62; April 1958.

Published by the University of Illinois.

Office of publication, 2 Administration Building (East), Urbana, Ill. (Price : One dollar.)

(1) The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress onjointly with the Office Bibliographique International, of Brussels, (See « Bibliographical Decimal Classification as applied to Railway Science », by L. WEISSENBRUCH in the number for November 1897, of the *Bulletin of the International Railway Congress*, p. 1509).

[016. 385 (05]

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Acier - Stahl - Steel, juin, p. 261.
FRANÇOIS (H.) & MESLET (J.). — **Reconstruction du pont de la gare à Saint-Omer.** (France). (1 000 mots & fig.)

1958 **624** .2
Acier - Stahl - Steel, juin, p. 271.
MAKOWSKI (Z. S.). — **Répartition latérale des charges dans un gril de poutres.** (3 000 mots & fig.)

Annales des Ponts et Chaussées. (Paris.)

1958 **721**
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DAVIN. — Etudes sur le **comportement dynamique des sols stratifiés.** *(Suite et fin.)* (7 000 mots.)

Bulletin de l'Association Suisse des Electriciens. (Zürich.)

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NEUBAUER (F.). — Experimentelle Untersuchungen über den **Einfluss verschiedener Befestigungsarten der Armaturen von Isolatoren auf die mechanische Festigkeit des Porzellans.** (3 000 mots & fig.)

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